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ABSTRACT

This science curriculum is an activity-oriented program in which an attempt has been made to provide sufficient information for non-science specialists to enable them to offer an effective course at the grades 10 and 11 levels. This curriculum offers a solution to the unique needs of life in the Canadian Northwest Territories. The role of technology in science and everyday life as well as the science/technology/society connection are emphasized. The students' needs, interests, abilities, and cognitive levels were the major criteria used in the selection and presentation of these activities and materials. The Science 25 Curriculum includes administrative guidelines, format/time allotments, unit outlines, curriculum details/resources, and elective units. The required units cover non-renewable/renewable resources, chemistry in daily life, construction science, and human pathology and health. The required units give detailed background information and laboratory activities on each topic. The elective units include: (1) astronomy; (2) human reproduction; (3) drug and alcohol abuse; (4) buying and selling; (5) nutrition; (6) getting enough oxygen; and (7) photography. Information is given on the content of the unit and where the materials for the unit can be purchased. A program evaluation questionnaire for use with students is appended. (KR)

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Science 25

Department of Education [illegible]

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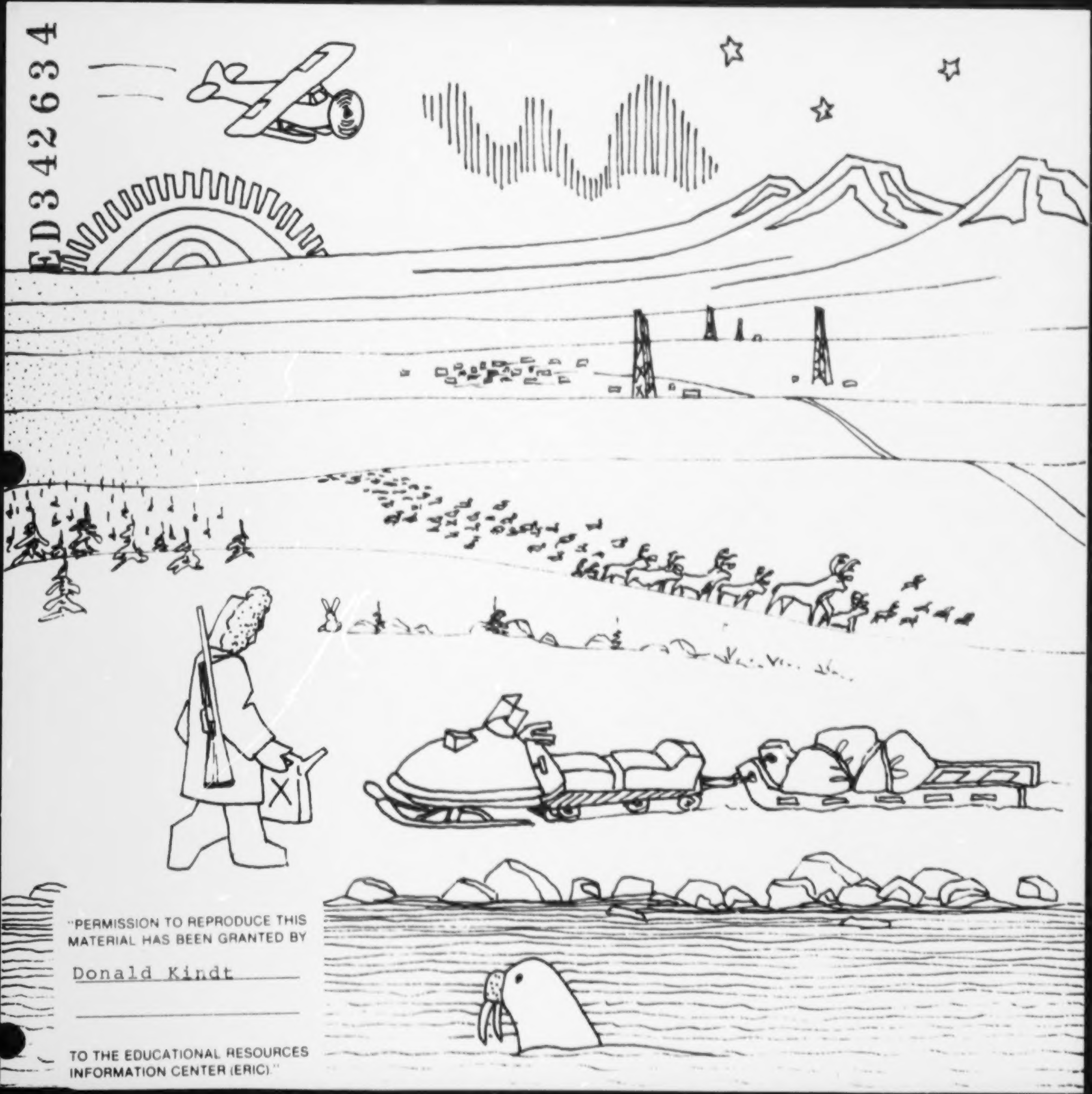

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CURRICULUM GUIDE

SCIENCE 25

REVISED (1988)

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INTRODUCTION

The Northwest Territories Science 15/25 Curriculum was originally designed so that students following the General Diploma rather than the Advanced Diploma route through high school would still receive instruction in science, not just at grade 10 but also in grade 11.

These courses offer a Northwest Territories solution to the unique needs of life in the Northwest Territories.

The Minister of Education for the Northwest Territories has approved Science 15/25 for credit under the Memorandum of Understanding between Alberta Education and N.W.T. Education

This Science Curriculum is an activity-oriented program and an attempt has been made to provide sufficient information to non-science specialists to enable them to offer an effective course at the grade 10 and 11 levels. A primary emphasis should be the continuation of the development of process skills initiated at the elementary and junior high levels.

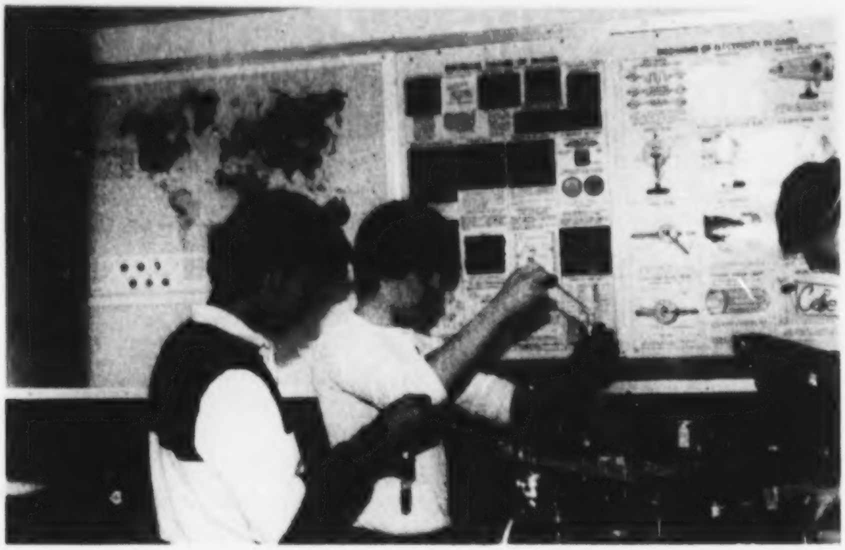
The teacher should also attempt to bring into play the role of technology in science and everyday life as well as the science-technology-society connection. The focus has therefore shifted from simply content and skills to one of the content-skills-science-technology-society. It is through this new emphasis that the course will become relevant to the student.

At all times the students' needs, interests and abilities must be the major criteria in the selection and presentation of activities and materials. Activities must be geared to the cognitive levels of the students.

Excessive terminology should not be emphasized. Making science understandable is the most important achievement that can take place in the classroom.

By way of a simplified Piagetian explanation for some of the above constraints, many (although not all) of the students entering this course will be at the concrete operational stage of cognitive development which, unlike the stage of formal operational thought, requires reference to things or situations with a real meaning in physical terms.

An important consideration in the presentation of this course is for many N.W.T. students, English is not their first language.



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GOALS OF SCIENCE EDUCATION

In our contemporary society, the role of Science and Technology is becoming increasingly significant. Science educators must re-think the goals of science if we are to comprehend and cope with the increasing impact of science and technology in our lives.

The Science Council of Canada in a recent deliberation has identified certain componenets in Science Education. These are: science knowledge, scienfic inquiry, general knowledge of scientific enterprise, the interdependence of science and society and our feelings or attitudes. In a document entitled "Towards Balance in Setting Goals for School Science Programs", they further define and characterize the scientifically literate individual as one with an understanding of the:

- basic concepts in science;
- nature of science;
- ethics that control the scientist in his work;
- interrelationships of science and technology;
- role of science and technology in societal issues.

To these broad goals, we add the aspiration of instilling an insight to the student of viewing the North as a unique environment with specific science problems and opportunities for scientific study.

OBJECTIVES OF THE HIGH SCHOOL SCIENCE 15/25 CURRICULUM

This curriculum will help and encourage the student to:

1. develop an understanding of self and an appreciation of worth as an individual.
2. develop a positive attitude toward science and a realization that science is a basic part of daily life.
3. gain a foundation of knowledge in the fundamentals of science.
4. improve and develop inquiry or process skills in science through exposure to varied activities and many scientific content areas.
5. consider interrelationships between people and their biological and physical environments.
6. develop critical thinking and reasoning skills and allow students to examine their own attitudes and values regarding various scientific issues.
7. contribute to the development of vocational knowledge and skill - to relate science to job and career opportunities in technology, industry, commerce and other areas in which science plays a role.

SCIENCE 25 CURRICULUM

Administrative Guidelines

Format/Time Allotments

Unit Outlines

Curriculum Details/Resources

Elective Units

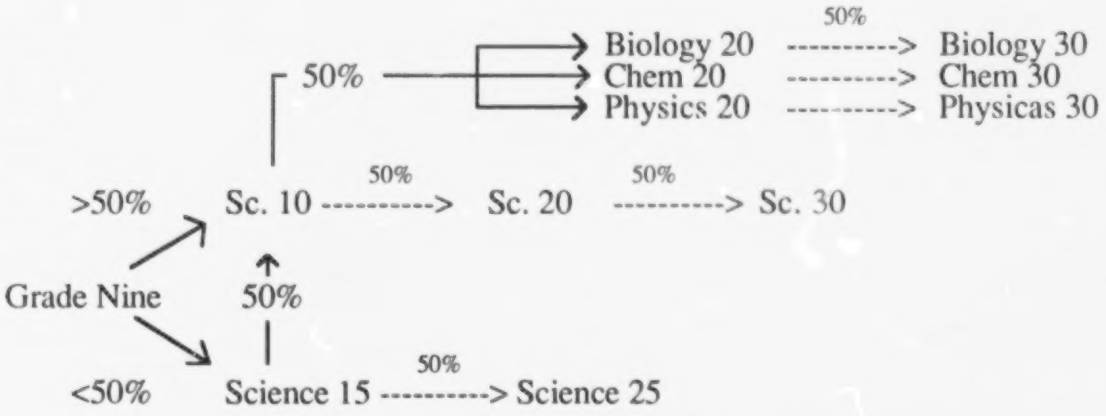
ADMINISTRATIVE GUIDELINES

The Minister of Education for the N.W.T. has approved Science 15/25 as locally developed courses for credit under the Memorandum of Understanding between Alberta Education and N.W.T. Education.

Science 25

1. This course may be offered for either three or five credits (75 hours or 125 hours respectively).
2. Students who take Sc 15 for 3 credits in grade ten must take the Sc 25 course for 5 credits in grade 11. Students who take Sc 15 for 5 credits in grade 10 may take the Sc 25 for either 3 or 5 credits in grade 11. In this way students will meet the graduation requirement of 8 credits in science.
3. A three credit outline includes the introductory section, 2 required units and 1 elective.
4. A five credit outline includes the introductory section, 4 required units and 2 electives. One of these electives may be a locally developed and approved unit.
5. Successful completion of Science 15 with a pass mark of 50% is a prerequisite for entrance into the Science 25 Course. Counsellors should consult the table located in these introductory pages to determine how other science students may enter the course.

TRANSFER REQUIREMENTS WITHIN, TO AND FROM THE HIGH SCHOOL SCIENCE CURRICULUM



Adequate counselling must take place when the student is choosing his/her route. Once a selection has been made, students should be encouraged to continue this sequence or move into the more challenging sequence.

N.W.T. SCIENCE 25
SCOPE AND SEQUENCE

SCIENCE 25

REQUIRED

INTRODUCTION

- Non-renewable/renewable resources
- Chemistry in our daily lives
- Construction Science
- Human pathology and health

ELECTIVES

- Using the skies
- Human reproduction
- Drug and alcohol abuse
- Buying and selling
- Let's eat
- Getting enough O_2
- Photography

TIME ALLOTMENT

3 CREDITS

Introduction 10 hours

2 Required Units

1 Elective (teachers may choose to cover a core unit in place of the elective component or they may use a locally developed and approved elective unit)

5 CREDITS

Introduction 10 hours

4 Required Units

2 Electives (one may be a locally developed and approved unit)

NORTHWEST TERRITORIES
GENERAL SCIENCE
UNIT OUTLINES

1. Introduction

   1.1 Course outline.

   1.2 Coursework expectations, marking and grading policies.

   1.3 Safety in the classroom and/or laboratory.

2. Non-Renewable/Renewable Resources

   Non-Renewable Resources

   2.1 Forms of energy.

   2.2 Exploration and Extraction in the N.W.T.

      - mining industry in the N.W.T.
      - metal mining
      - exploration for oil and gas in the N.W.T.
      - drilling for oil in the N.W.T.

   2.3 Environmental problems

      - mining and pollution
      - air pollution
      - acid rain, arsenic and mercury
      - hazardous wastes
      - oilspills and blowouts
      - oil and the arctic marine environment

   2.4 Jobs and careers

   Renewable Resources

   2.5 Management of renewable resources

      - game
      - fur bearing
      - sea mammals
      - fisheries
      - forestry
      - agriculture

   2.6 Surveys

      - data collection techniques
      - raw data, estimates

2.7 Population Dynamics

2.8 Quotas

2.9 Limiting factors

- carrying capacities

2.10 Management agencies

- control and jurisdiction

2.11 Man-made habitat changes

2.12 Endangered species

3. Chemistry in our daily lives

3.1 Kitchen chemistry introduction

- acids and bases
- cabbage juice labs
- scientific information on labels and in product advertising

3.2 Basic atomic theory

- Bohr model of the atom
- nuclear particles
- electrons
- formation of ions
- basic chemical bonding
  - covalent
  - ionic

3.3 Physical and chemical changes

- ice cream in a test tube (example)

3.4 Solutions

- solubility
- saturated and unsaturated solutions
- crystal experiments

3.5 Application of chemical techniques

Teachers should choose experiments from the list below which are appropriate for their students' interests and abilities. Spend about ten periods on this section.

- rating different brands of toothpaste
- shampoo
- antacids

- lubricating oils
- the components of coffee
- headache preparations
- making cold cream
- natural and synthetic fibres
- making lipstick
- clearing the water
- relative hardness of water samples
- determination of Vitamin C
- food components
- effects of cigarettes on living animals
- the action of soap

Other possible sources of experiments are also included in the detailed plans section.

4. Construction Science

4.1 Building homes

- types of homes, design, and identification of materials used in modern building construction.
- traditional building materials
- experiments - making and testing mortar
  - making and testing concrete

4.2 Metals

- types
- protection of metals
- soldering and welding
- experiments - damage to metals
  - protecting metals
  - joining metals

4.3 Bridges

- types and shapes
- experiments - testing bridge shape
  - class contest to construct bridge which can withstand most stress

4.4 Water and building materials

- uptake of water by building materials
- vapour barrier
- experiments - uptake of water
  - water and brick

4.5 Heat Loss and Gain

- insulation
- heat flow (heat loss and gain)
- experiments - heat travelling through materials
  - energy and surfaces
  - keeping the heat in

4.6 Solar energy

- passive and active solar systems
- solar cells
- experiments - trapping light energy

4.7 Plastics

- structure of plastics
- experiment - testing plastics with light

4.8 Energy and heating systems

- how to measure energy consumed
- forced air
- hot water
- furnace theory
- heat exchangers

5. Human Pathology and Health

5.1 Review of organ systems

5.2 Agents of disease

- pathogenic organisms - viral, bacterial, fungeal, large parasites
- genetic
- nutritional - include fetal alcohol syndrome
- hygienic

5.3 Disorders - those which are relevant

trichinosis
botulism
tapeworms
roundworms
V.D.
bronchitis
asthma
pleuresy
obesity
tuberculosis
collapsed lung
cancers
CO poisoning
diabetes
hepatitis
heart attacks
fetal alcohol syndrome
drug and alcohol abuse
hypothermia

5.4 Methods of analysis

5.5 Cures

- antibiotic
- nutritional guidance
- hygiene guidance

ELECTIVES

Three electives must be taken to complete the five credit course requirements. Only the five credit outline allows time for elective units. One of these electives may be a locally developed and approved unit.

When counselling vocational students for the Northwest Territories High School Certificate Program, careful note should be taken of the elective stream the students are allowed to follow. It is strongly recommended that vocational students follow the five credit course if the vocational electives are available in the school.

PROGRAM DETAILS

These details have been provided primarily for those teachers with little Science background who find themselves teaching Science 25. It is anticipated that experienced Science teachers will develop their own plans from the unit outlines. The plans that follow are merely suggested and/or typical examples of how you might proceed. They do not attempt to cover every single aspect/concept of the course.

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1. INTRODUCTION (1 hour)

OBJECTIVES

After completing the introductory classes (1-2 class periods), the teacher will be able to:

Identify those students who would be better suited to a different course.

Identify possible elective units if a 5-credit course is being offered.

Identify the modifications which will probably have to be made to subsequent units to meet the needs of students.

After completing the introductory sessions, the student will be able to:

Appreciate the work and effort requirements of the course.

Have an understanding of what topics will be covered during the course.

Appreciate the need for concern regarding safe laboratory practices.

Select and use appropriate reporting formats

DISCUSSION AND ACTIVITIES

It can be seen from the above objectives that this unit is intended to familiarize the teacher and students with each other and also to develop or review a number of skills or concepts relating to course work, class assignments and safety in the laboratory.

It is suggested that approximately 1 hour would be needed to discuss these topics with the class.

2. NON-RENEWABLE/RENEWABLE RESOURCES (29 hours)

This unit may be dealt with in two sections. Approximately 15 hours may be spent on each one. The first section is Non-Renewable Resources.

NON-RENEWABLE RESOURCES (Approximately 15 hours)

OBJECTIVES

After completing this unit students will be able to:

Name the active renewable resource extraction location(s) in their region.

Name the resource(s) being extracted.

Describe the probable geological sequence leading to the formation of that (those) resource(s).

Describe the procedures and reasons for the resource exploration activities presently being undertaken in their region or which have been undertaken in their region.

Describe and explain the actual or proposed extraction and transportation procedures for non-renewable resources in their region.

Outline some of the chemical and/or physical principles involved in the refining and utilization of the resource(s) extracted from their region.

Identify some of the environmental problems created by resource exploration, extraction and transportation.

Describe some of the jobs available in the resource industry and the qualifications necessary for those jobs.

Discuss the importance of their resource in terms of world demand and production.

DISCUSSION AND ACTIVITIES

Several topics in the Middle Years Science Program should provide background to your students:

E7.3	Minerals
E8.3, 8.4	Mining, oil and gas
L9.2	Northern environmental problems

If it is found that the students have retained a solid background in local non-renewable resources, you may wish to consider alternate resources such as:

1. Fossil Fuels (Ginn and Company)

This book deals with fossil fuels and their many uses, a discussion of why the supply of fossil fuels is limited and the decisions people need to face because of that. Also deals with gasoline and coal and pollution and energy. Activities deal with products of fossil fuel production, energy conversion from one form to another and fuels from recycling.

663-37910-5	Student Book	$5.30
663-37916-4	Teacher Text	$8.60
663-37921-0	Duplicating masters (test)	$16.95

Available from:

Ginn and Company
3771 Victoria Park Avenue
Scarborough, Ontario
M1W 2P9

2. Alberta Tar Sands Kit

This kit has been designed specifically for use in Science courses of a general nature. The unit consists of five sections:
a) The Tar Sands - Past, Present and Future
b) Laboratory Activities
c) Fact Sheets
d) Student Evaluation
e) Visual Aids

Laboratory activities deal with separating the bitumen from the tar sands and upgrading the bitumen to the state where it can be burned. Activities also include observing the tar sands under a microscope and determining the importance of the water layer in the tar sands.

Fact sheets provide an overview of data pertaining to the occurance, history and geology of tar sands and of reserves of oil.

Student evaluation consists of a short test of 10 multiple questions and three written questions.

Visual aids include eleven (11) illustrations suitable for making overhead projector transparencies or duplication.

3. Environment Canada has two publications on acid rain that may prove to be quite useful.

   a) Acid Rain - the forecast for Western Canada.
   b) Downwind - the acid rain story

   Available from:

   Information Directorate
   Environment Canada
   Ottawa, Ontario
   K1A 0H3

4. Science Advisory Board of the Northwest Territories publication entitled "Acid Deposition Perspective for the N.W.T."

   Available from:

   Science Advisory Board of the N.W.T.
   P.O. Box 1617
   Yellowknife, N.W.T.
   X1A 2P2

A proposed outline for non-renewable resources is given below. Suitable articles for each topic follows the outline. This is only a suggested outline. Teachers may prefer to use other resources and materials.

Content

1. Forms of energy (energy crisis)

2. Exploration and extraction in the N.W.T.

   - mining industry in the N.W.T.
   - metal mining
   - the need for oil
   - exploration for oil and gas in the north
   - drilling for oil and gas in the north

3. Environmental problems

   - mining and pollution
   - air pollution
   - acid rain, arsenic and mercury
   - hazardous wastes
   - oilspills and blowouts
   - oil and the arctic marine environment

4. Jobs and careers

SUGGESTED CONTENT/OUTLINE FOR NON-RENEWABLE RESOURCES UNIT

INPUT

Canadians use more energy per person than people in any country of the world.

We use energy
- to run our vehicles.
- to heat our buildings.
- to manufacture products we use.
- to process our food.
- to produce electricity.
- to run all our other machines and appliances.

When people talk about an energy crisis, they usually mean a shortage of oil. More of our energy comes from oil than from any other source.

We can develop other forms of energy, but it will take a few years. When world oil prices began to rise a few years ago, we were caught. We did not have vehicles that could run on other fuels. We did not have enough power plants that produced electricity with other fuels. We had too many oil furnaces in our homes and buildings. We had to pay the high prices for the oil we brought in from other countries.

The North depends even more heavily on oil than the rest of the country does.

OTHER TYPES OF ENERGY

Solar Energy: Energy from the sun may be used in two ways:

Directly: The sun's heat is used to heat air, as when the sun shines through a window. Some northern houses are now being designed with south-facing windows to use the sun's heat to heat the inside.

The sun's heat may also be used to heat water. Water holds heat better than air does. At night when the sun is not shining, the house is heated by the water in pipes.

Indirectly: The sun's heat is used to charge batteries. In the batteries, the solar energy is changed to electricity. Then the batteries are used to run electric motors or appliances.

The problem is, it takes very large batteries to store much energy. It would be hard to store enough solar energy to power a normal Canadian household.

Wind Energy: Wind turns some kind of windmill. The mechanical energy of motion is changed into electricity.

It may be stored in batteries, or used to power a generator. Equipment to store wind energy as electricity takes a lot of space.

Tidal Energy: In many places there is a large change in sea level between high and low tides. The flow of the water may be used to produce energy.

Hydrogen: Hydrogen is a gas. It is easily available from water. (Water is made from hydrogen and oxygen.) However, hydrogen is very explosive. There are many scientists working to develop motors that will run safely on hydrogen.

Natural Gas and Propane: These two fuels are already widely used for heat to produce electricity. They may soon be widely used as fuel in cars as well. In Europe there are already many cars that run on propane. These fuels are readily available in Canada.

Gasohol: This is a mixture of gasoline and alcohol. The alcohol is made from grain. This fuel is easy to substitute for gasoline in places that have extra crops that can be turned into alcohol. In the central part of North America where farmers grow a lot of wheat and corn, gasohol is being used by many people for their cars. It is cheaper than gasoline.

Garbage: Some cities are trying to develop ways to turn the heat of burning garbage into energy that can be used to heat buildings or even to make electricity.

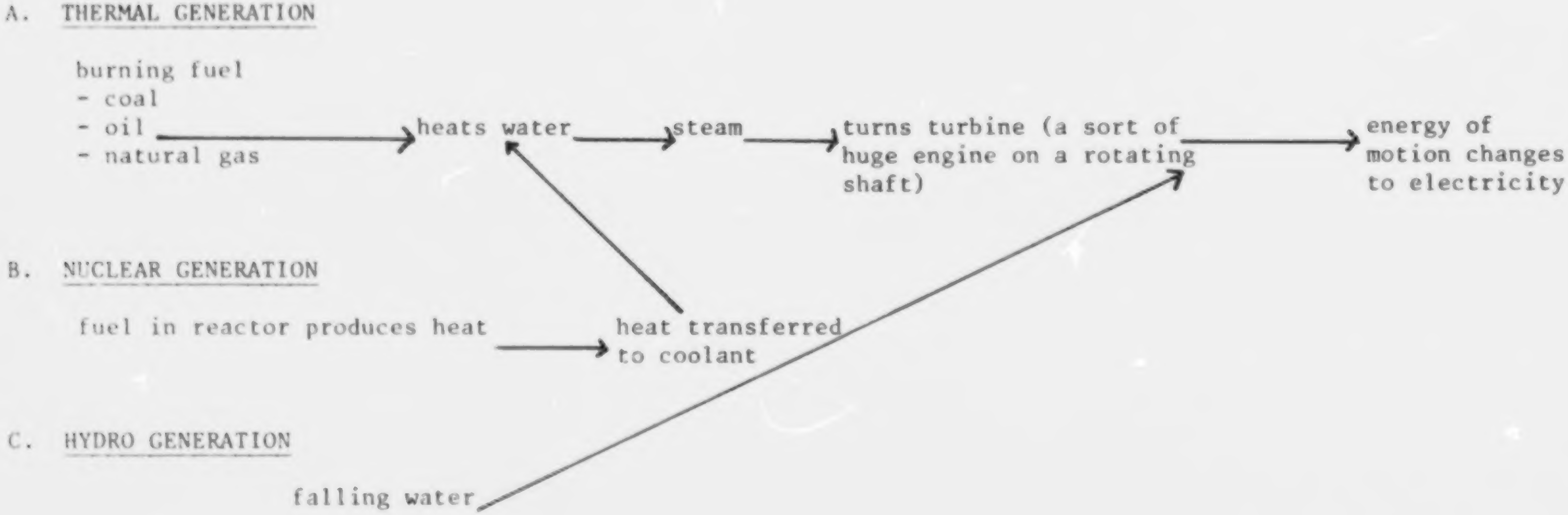
This may be worthwhile in big cities that have a lot of garbage.

KEY WORDS

energy
wind power
hydrogen
propane
gasohol

thermal electricity
nuclear energy
hydro electricity
solar energy
tidal energy

HOW IS ELECTRICITY PRODUCED?



A. THERMAL GENERATION

burning fuel
- coal
- oil → heats water → steam → turns turbine (a sort of huge engine on a rotating shaft) → energy of motion changes to electricity
- natural gas

B. NUCLEAR GENERATION

fuel in reactor produces heat → heat transferred to coolant → heats water

C. HYDRO GENERATION

falling water → turns turbine

WORKCARD

1. What are all the uses of energy in your community? Mark with a (*) the ones that depend on oil.

2. WHAT IF:

   - your community's oil supply was suddenly cut off. Write a story about it. How would life be different? What would people do?

3. What alternate sources of energy could your community use?

4. Why is it important to save energy?

5. What can you do to save energy?

6. Make posters to show people how to save energy.

7. Which method of producing electricity do you think produces the least pollution? Why?

INPUT

Uranium is a radioactive mineral. This means that it is constantly giving off energy. This energy is called radiation. Uranium has a tremendous amount of energy stored in it.

Scientists have found ways to release the energy that is stored in uranium. They can turn this energy into electricity. The energy produced from uranium is called nuclear energy. The energy from uranium is released in a nuclear reactor. A great deal of electricity can be produced from a very small amount of uranium.

It takes: 15 grams of uranium
or 230 litres of oil
or 310 kilograms of coal

to power one 100-watt light bulb non-stop for one year.

Because of the energy crisis, there is likely to be more and more nuclear energy used to produce electricity. However, many people feel that nuclear energy is too dangerous to use.

Radiation in very high doses makes people very sick or causes death. Atom bombs are weapons that kill people by suddenly releasing vast amounts of explosive energy and harmful radiation.

Only two atomic bombs have ever been used. They were dropped on Japan at the end of World War II. Thousands of people died instantly or soon after the bombs were dropped. In the years after the war, many babies were born with terrible deformities, and many people who had been exposed to radiation got cancer.

Now scientists know that even quite low levels of radiation can cause cancer in human beings. The cancer may take twenty years or more to develop.

Many people in Canada and the United States think that nuclear energy is too dangerous to use. They say that it is impossible to keep radioactive materials from getting into the environment.

But many other people feel that nuclear energy is as safe as any other type of energy. They say that there are plenty of safety measures built into nuclear energy plants. Because nuclear energy is so dangerous, there are many laws that control the use of it. The laws are very tough to ensure that it is safe.

URANIUM MINING AND REFINING

A uranium mine is very like any other metal mine. It has some problems that can be controlled if the right safety precautions are taken.

Uranium is dangerous to mine workers if they inhale it as a dust. Therefore, dust in uranium mines is kept down by spraying.

Radon is a radioactive gas that is present in the air of a uranium mine. It can cause health problems if the miners inhale it. Therefore it is important to bring lots of fresh air into uranium mines, and to clear the stale air out of the mine.

99.9% of uranium ore is waste. When the ore is milled at the minesite, the final product is called yellow-cake. It is a powder the color of mustard.

Canadian yellow-cake is shipped in large drums to a refinery at Port Hope, Ontario (just east of Toronto). It is made into solid fuel pellets.

The pellets are put into rods and the rods are put into bundles. These bundles are the fuel used to produce nuclear energy.

URANIUM IN THE NORTH

There is a lot of uranium in the N.W.T. Uranium is found in the hard rock of the Canadian Shield.

Right now there is not enough demand for uranium to open up mines in the N.W.T. No uranium is being mined in the N.W.T. at the present time (1982).

But because of the energy crisis, it is likely that more and more countries will turn to nuclear energy in the future. Then a lot of countries will want to buy uranium from Canada.

Radium, which is a radioactive mineral related to uranium, was found on Great Bear Lake in 1930. Materials for the first atomic bomb came from this mine.

HOW IS NUCLEAR ENERGY PRODUCED?

Canadian scientists have developed a nuclear reactor called a Candu Reactor. The Candu Reactor is a bit different from the type of reactor used in the United States. The Candu system is more expensive to operate than the American system, but many scientists feel that it is safer.

The fuel bundles are put into the core of the reactor. The reactions that happen in the core are very complicated. You will learn more about them in science classes later on.

Basically, the incredible energy that is stored in the uranium is released in the form of intense heat.

The heat is transferred to a fluid called a coolant. Then it heats water that changes to steam. The steam runs a turbine which produces electricity. (See the section on Energy.)

WHAT ARE THE PROBLEMS WITH NUCLEAR ENERGY?

1. Thermal Pollution

Water used in the plant carries heat back into the lake or river it came from. If the water temperature increases very much the following can happen:

- cold water fish (such as trout) may die.

- Warmer water makes water plants and animals grow faster. They use more food and oxygen. They don't grow as fast or live as long.
- Some fish won't reproduce.
- More algae grow.
- Warmer water holds less oxygen, yet more is needed for living things and for decay.

2. Radiation Pollution

Radioactivity may escape from these plants into the surroundings. The engineers who build these plants build in all sorts of safety factors. There are devices to shut down everything automatically if any radiation begins to escape or if anything goes wrong.

If the coolant stopped flowing or leaked out, the temperature of the reactor would rise very quickly. If the temperature rise could not be stopped, the reactor would melt and radioactivity would escape.

A meltdown would release incredible amounts of harmful radioactivity into the environment.

3. Used Fuel

After about a year and a half, the fuel bundles have to be changed. The used fuel is still very radioactive. It will take about 10,000 years for it to lose enough radioactivity to make it about the same as uranium in the ground.

No one has yet found a good way to get rid of the used fuel.

In some countries it has been dumped down old mine shafts. Some countries have dumped drums full of radioactive waste into the ocean.

In Canada all the fuel that has been used in nuclear energy plants is still stored in large water pools at the plants. The water cools the bundles and blocks radiation so that it isn't released into the air.

Final storage in non-porous rock chambers deep underground appears to be the only safe way to dispose of radioactive waste.

4. Health Problems

The results of exposure to radiation may take many years before they show up. People in high risk areas are miners, plant workers, waste handlers, and those who live near nuclear plants.

5. Nuclear Accidents

Over the many years of experimentation with nuclear plants around the world, there have been quite a number of accidents. Most countries prefer to keep quiet about the accidents to prevent public protest.

At Port Hope, Ontario, high levels of radon gas were discovered in houses and schools. Nuclear waste was found in the soil; cancer has been found among the residents and a government health survey is being carried out.

At Three Mile Island in the U.S.A., a breakdown in the cooling system caused a near melt-down in 1979. Some radiation was released into the atmosphere and there was a mass evacuation of people living nearby. The eventual clean-up bill will exceed a billion dollars and public concern over nuclear generating plants is increasing.

NUCLEAR ENERGY IN CANADA

Ontario has several nuclear energy plants, with plans for more. Quebec and New Brunswick also use nuclear energy. Manitoba is considering its use.

Suggestions have also been made that the smaller slow-poke reactor, made by the Atomic Energy Commission, would provide low-cost energy for remote NWT communities but no decisions have been made.

KEY WORDS

uranium
radiation
silicosis
radon
pellets
rods
coolant
radioactive dust
yellow-cake
Candu reactor
thermal pollution
radiation pollution
meltdown

NUCLEAR ENERGY

WORKCARD

1. What are the advantages of nuclear power? What are the dangers?

2. The accident at Three Mile Island released a lot of radiation into the environment. If you were a scientist, what would you do to keep track of health problems caused by that radiation?

3. Why is it hard to prove that a certain health problem was caused by radiation?

4. What benefits would uranium mining bring to the N.W.T.?

5. Try to find out if there is uranium in your area. Your local government or economic development officer might know if there has been exploration for uranium in your area. Your community council might know.

6. Imagine that a uranium mine is about to open near you. You are a health inspector. What rules would you make to protect the health of the mine workers?

7. It costs a lot of money to bring oil into northern settlements. What advantages might there be in using nuclear energy in the north?

8. Why is it hard to find a good place to store used nuclear fuel?

THE MINING INDUSTRY IN THE N.W.T.

INPUT (COURTESY OF THE N.W.T. CHAMBER OF MINES.)

MINERALS - WE DEPEND ON THEM

Zinc: for alloys such as brass, coated nails and steel, compounds used in processing rubber, in ceramics, photoengraving printing plates.

Lead: For batteries in cars and trucks, radiation shielding, lead weights, pipelines.

Gold: For jewellery, decoration, dentistry, aerospace industry, electronic equipment.

Cadmium: For nickel-cadmium batteries, manufacture of pigments.

Copper: For electrical wiring in appliances, computers, bronze and brass alloys.

Tungsten: For machine tools, drilling bits, filaments for incandescent lamps.

Silver: For photographic chemicals, solders, bearings, mirrors, coins, jewellery.

Uranium: For atomic power generation, compounds used in photography, medicine, ceramics, dyeing silk and wool. (Uranium exists in the Territories, but is not mined at present.)

MINERAL PRODUCTION N.W.T., 1979

Gold	5,304,119 g	$ 61,750,361
Silver	105,651,075 g	44,566,187
Copper	554,769 kg	1,330,685
Lead	62,436,000 kg	82,850,000
Zinc	229,600,000 kg	219,531,000
Cadmium	206,634 kg	1,302,873
Tungsten	3,275,073 kg	58,484,430
		$469,815,536

BENEFITS ...FROM NORTHERN MINING (1977 figures)

Federal Income Taxes	$ 7,678,000
Mining Royalties - Federal Government	1,590,000
Gasoline and Fuel Oil Taxes - Territorial	403,000
Property, School, Business Taxes	699,000
Wages and Salaries	42,265,000
Employee Benefits	11,274,000
Grants and Donations	1,107.000
Community Facilities (includes operating)	9,184,000
Supplies and Services in the N.W.T.	7,000,000

RESPONSIBLE DEVELOPMENT ... BENEFITS ALL OF US

PINE POINT began producing in 1964 but it was 66 years earlier in 1898 when prospectors heading for the Klondike found the zinc-lead showing at Pine Point. Today, 565 people work at Cominco's operation south of the Great Slave Lake.

GIANT YELLOWKNIFE, now part of the Falconbridge group, was staked as a gold property on the west side of Yellowknife Bay in 1935. The first brick was poured in 1948. Giant has 345 employees.

CON poured the Territories' first gold brick in 1938 in Yellowknife. Con, a Cominco operation, employs 250 men and women.

NANISIVIK began production in 1976. Lead-zinc was reported in the area on Baffin Island as early as 1910. The project is managed by Strathcona Mineral Services. Two hundred people work at the mine site.

ECHO BAY operated at the old Port Radium Eldorado Mine site as a silver and copper producer between 1965 and 1982.

CAMLAREN was first discovered in 1936, the mine closed and has just reopened in 1980. The gold mine which is a 12-month operation is 80 km northeast of Yellowknife and will employ 65 people. The mine is operated by the Mining Corporation, a subsidiary of Noranda.

CANTUNG is a tungsten producer in the N.W.T. but on the Yukon border. Canada Tungsten opened this property in 1971 as an open pit operation and began underground operations in 1974. Two hundred and ten employees work at the mine site.

POLARIS on Little Cornwallis Island in the high Arctic is a zinc-lead property operated by Cominco. Mineralization was discovered on the Island in 1960 and the Polaris zinc-lead deposit was found in 1971. Cominco expects 233 people will work at the Polaris Mine which began production in 1982. Mine life is anticipated to be 25 years.

TERRA located near Port Radium on Great Bear Lake staked the property for silver in 1966 and began production in 1969. The area's mineral potential was recognized as early as the late 1920's. Today, Terra employs 65 people in the Territories.

*Figures on employment are approximate for 1982.

THE MINING INDUSTRY IN THE N.W.T.

WORKCARD

1. Make a list in your notebook as follows:

MINERAL	USES OF THE MINERAL IN YOUR COMMUNITY

2. Read the list of benefits from northern mining. Compare it with the list you made for the last work card. Are there any benefits you missed?

3. Make up a survey to find out how people in your community feel about having a mine near them. (The survey might ask about a mine that already exists near you, or it might be about a mine that might be built in the future.) You will need to make up a lot of different questions. The best surveys usually have lots of simple questions with places to check off the answers. For example:

CHECK THE ANSWER YOU WANT.

	YES	NO	MAYBE	DON'T CARE
Should there be a mine near your community?				
Do you want to work in a[illegible]ne?				

Make up lots of different questions. You can work in groups or your whole class can make one survey. Then go around the community and ask people the questions. Check off their answers.

4. After you have collected answers to your survey questions, make a chart to show how people answered. Write a short report on how people feel about having a mine nearby.

5. What do you think are good and bad points about having a mine near your community.

INPUT

A mine is established at the source of the ore. Ores can vary from almost pure metal to a little bit of metal combined with a lot of rock, sand or mud.

A opencut mine has ore that is close to the surface and the ore can be removed directly from an open pit or hillside, or scraped off the surface.

An underground mine goes in search of the ore deep in the rock through tunnels and underground rooms.

Ore extraction is carried out by:

1. Drilling and blasting the rock face into pieces small enough to bring to the surface.
2. Mucking, or picking up the ore with mechanical shovels or by hand.
3. Transporting the ore, with trucks, trams, conveyors and hoists.

Ore may be processed at the mine site, or at a mill removed elsewhere from the minesite by:

1. Crushing and grinding the ore into a fine powder, then...
2. Separating the ore from the waste by methods of flotation, sedimentation, magnetism, centrifuge and others, then...
3. Smelting the metal, usually with very high heat, to melt down the final pure product.

AN UNDERGROUND MINE

(Diagram courtesy of Con Mine, Yellowknife)

This diagram illustrates the activities that go on in Con Mine, an underground mine in Yellowknife.

Here are some definitions that will help you interpret this diagram:

ORE: A mixture of minerals and rock from which at least one of the minerals can be extracted at a profit.

DRIFT: A horizontal underground tunnel in such a direction that it follows or 'drifts' with the ore or an ore vein or favourable rock.

CAGE: A sort of elevator which moves men and materials up and down the mine shaft.

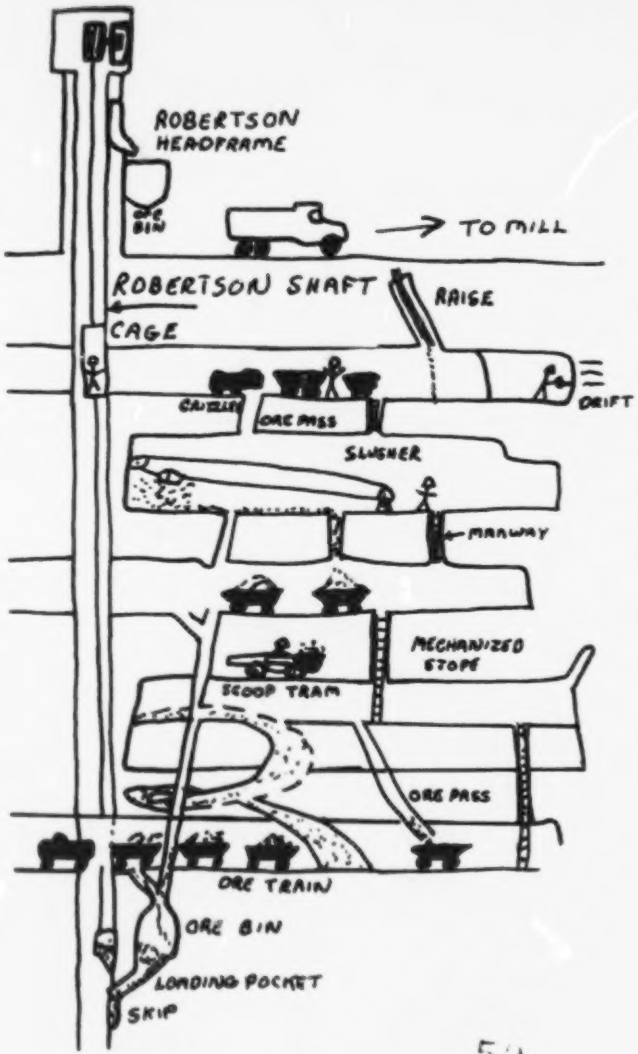
CHUTE: An opening in mine workings through which ore is moved after it is first mined to waiting carriers, such as mine cars, for transportation to a crusher.

GRIZZLY: A grating plate over the top of a chute or ore pass to stop the larger pieces of rock or ore.

SHAFT: An opening cut downward from the surface for transporting people, equipment, supplies, ore, and waste. It is also used for ventilation and as an auxiliary exit. It is equipped with a surface hoist system which lowers and raises a cage in the shaft, as well as 'skips' or containers for bringing up ore or waste.

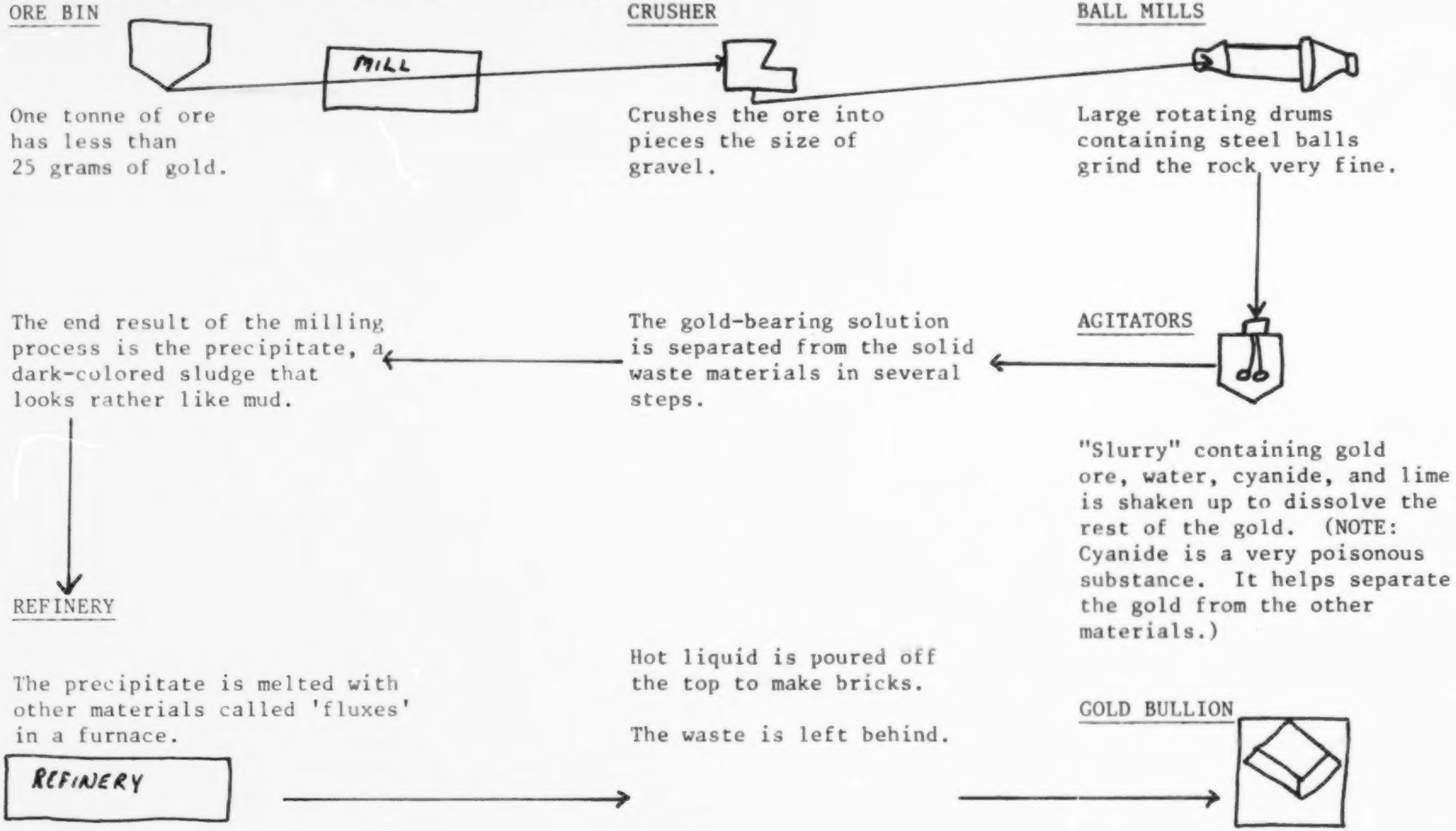
STOPE: An opening underground in which ore or waste is blasted and broken.

The men working in the stopes are engaged in drilling and blasting or in loading the broken ore.


ROBERTSON HEADFRAME
ORE BIN
TO MILL
ROBERTSON SHAFT
RAISE
CAGE
DRIFT
GRIZZLY
ORE PASS
SLUSHER
MANWAY
MECHANIZED STOPE
SCOOP TRAM
ORE PASS
ORE TRAIN
ORE BIN
LOADING POCKET
SKIP

REFINING GOLD

This is the process used at Con Mine in Yellowknife.



ORE BIN

One tonne of ore has less than 25 grams of gold.

CRUSHER

Crushes the ore into pieces the size of gravel.

BALL MILLS

Large rotating drums containing steel balls grind the rock very fine.

AGITATORS

"Slurry" containing gold ore, water, cyanide, and lime is shaken up to dissolve the rest of the gold. (NOTE: Cyanide is a very poisonous substance. It helps separate the gold from the other materials.)

The gold-bearing solution is separated from the solid waste materials in several steps.

The end result of the milling process is the precipitate, a dark-colored sludge that looks rather like mud.

REFINERY

The precipitate is melted with other materials called 'fluxes' in a furnace.

Hot liquid is poured off the top to make bricks.

The waste is left behind.

GOLD BULLION

KEY WORDS

ore
opencut
underground mine
mucking
crushing
grinding
concentrate
smelting
refining
milling
bullion
slurry
mineral
toxic metals
processing water
mine tailings

METAL MINING

WORKCARD

1. What kinds of accidents do you think might occur in an underground mine?
2. What dangers to health do you think there might be in a mine?
3. What kinds of pollution do you think mining might cause?
4. The mining industry is the largest industry in the N.W.T. What benefits does mining bring to the N.W.T.?

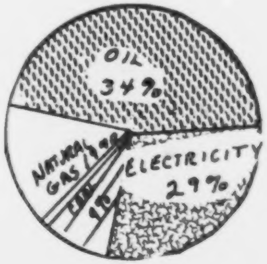
THE NEED FOR OIL

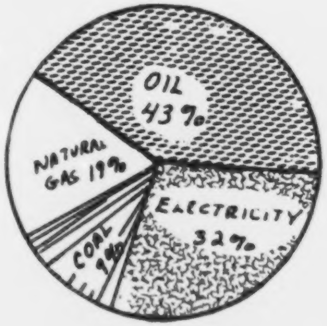
INPUT

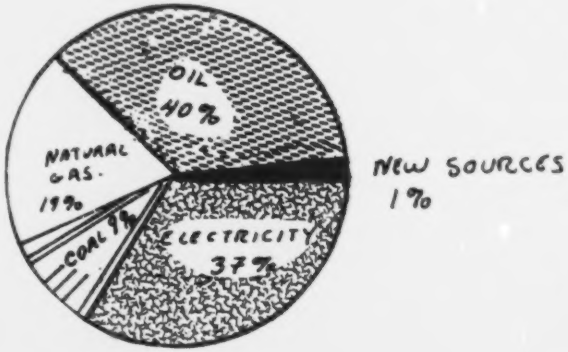
Over the last hundred years, Canadians have become more and more dependent on oil. We use oil

- to produce electricity.
- to heat our houses and other buildings.
- to make gasoline for our vehicles.
- to make diesel fuel, lubricants and grease.
- to make plastics, chemicals, medicines, synthetic fabrics, cosmetics, and other products.

Even if we substitute other fuels for oil and gasoline, we would still need oil to make all those other products.







This forecast for Canada's energy use for the next 15 years helps to place alternate sources of energy into perspective.

The relative size of each disc shows the growth of total Canadian energy demand. Oil's share of this growth is expected to drop while electricity's share, including nuclear power, should increase. The roles of both coal and natural gas are expected to remain constant. New renewable sources of energy, like solar and tidal power, will probably only account for one percent of our national energy use by the year 1995.

WHO NEEDS OIL AND GAS?

Petrochemicals are made from oil and gas. These are some products that are made from petrochemicals. The petrochemical industry uses about 4.5% of the oil and gas used in Canada.

raincoats
floor polish
tablecloths
reclining chairs
boat covers
tote bags
dishwashing liquids
unbreakable dishes
toothbrushes
extension cords
combs
watchbands
flight bags
toothpaste
drip-dry dresses
tents
stadium cushions
finger paints
foul weather gear
refrigerants
rugs
nightgowns
hair curlers
lipstick
laminates
ice cube trays
typewriter cases
swimming pool liners
laundry softeners
electric blankets
tennis rackets
shirts
drinking cups
canisters
house paint
lamp shades
computer tape
movie film
hair dryers
guitar strings
ammonia
plastic foam coolers
gaskets
brake fluid
jugs
bathrobes
eyeglasses
venetian blinds
vinyl tops
digital clocks
draperies
ice chests
life jackets
audio tape
T.V. cabinets
model planes
car battery cases
measuring tape
hockey pucks
ice buckets
tool racks
folding chairs
charcoal lighter
picture frames
air mattresses
yarn
wall plugs
insecticides
fishing lures
hoses
perfumes
shoe polish
petroleum jelly
snorkels
faucet washers
traffic cones
corrosion inhibitors
signs
pipes
projection screens
slide trays
squeeze bottles
soil conditioners
cortisone
ski poles
vinegar
mouthwash
oven bags
paint brushes
air filters
balloons
LP records
vaporizers
solvents
antenna cable
roofing
cold cream
carbon paper
fishing nets
artificial turf
sports car bodies
tires
knitting yarn
denture adhesive
water pipes
shopping bags
pails
vinyl shingles
switch plates
shower curtains
sponges
detergents
beach balls
ties
sunglasses
records
typewriter ribbons
footballs
doorknobs
sewing machine cases
fishing reels
mattresses
lifeboats
diving boards
glue
plastic drains
kitchen gloves
jackets

fishing rods
linoleum
shower caps
zippers
safety glasses
plastic wood
stuffed animals
car mats
soft contact lenses
garbage bags
thermal blankets
drinking straws
foam insulation
hand lotion
shampoo
shaving cream
sails
soft bumpers
erasers
radio cases
awnings
knitting needles
fan blades
wigs
window shutters
salad bowls
punching bags
model ships
shavers
plywood adhesive
aspirin
no-wax floors
permanent press clothes
oxygen masks
golf balls
ink
lighter fluid
heart valves
attaché cases

crayons
steering wheels
wet suits
disposable diapers
food wrap
laxatives
parachutes
stretch pants
telephones
enamel
wall coverings
transparent tape
acrylic paints
antiseptics
vacuum bottles
safety flares
warm-up suits
bearing grease
overcoats
bubble baths
planters
football pads
tiles
deodorant
panty hose
dish drainers
rubbing alcohol
epoxy paint
windshield wipers
upholstery
phonographs
hearing aids
car sound insulation
pacifiers
dresses
cassettes
garment bags
luggage
kitchen counter-tops

antifreeze
earphones
flashlights
windbreakers
motorcycle helmets
clothesline
antibiotics
shower doors
soap dishes
shorts
syringes
shoes
volley balls
refrigerator lining
electrician's tape
model cars
sandwich bags
microfilm
football suits
cameras
shoelaces
piano keys
bikinis
bracelets
football helmets
anesthetics
artificial limbs
bandages
dentures
car seats
bumper guards
boats
fan belts
eyeshadow
typewriter keys
wire insulation
t-shirts
golf bags
skin conditioners

photographs
outdoor carpeting
tool boxes
salt shakers
screen door screens
caulking
outboard motor housings
tape recorders
distributor housings
window shades
curtains
lids
pan handles
vitamin capsules
dashboards

THE NEED FOR OIL

WORKCARD

1. List the ways that oil and oil products are used to produce energy in your community.
2. Which products of the petrochemical industry do you use?
3. Imagine that your community could no longer get oil or products made from oil. Write a story about life without oil.
4. How has oil made life easier for northern people?

63

64

INPUT

A lot of oil and natural gas has been found in Canada, mostly in Alberta. The oil that is used in Western Canada comes from Alberta. Oil from Alberta is sent as far east as Ontario. Quebec and the Maritime provinces use oil that is brought in from other countries. It was much cheaper to do that than to bring oil all the way across Canada.

THE WAY IT USED TO BE

For many years there was lots of cheap oil available in the world.

World oil reserves increased year after year. Oil reserves refers to oil that is in the ground and has already been discovered. When oil companies find oil, they guess at how much is in the ground in each oil field.

People in Canada thought we had far more oil than we would ever need. Lots of oil from Alberta was sold to the United States.

Oil companies thought that there was probably oil in the Arctic, but people thought that it would never be worth looking for that oil. They thought that it would cost so much to move the oil from the Arctic to Southern Canada that it wasn't even worth looking for. That was when oil from other countries was cheap.

THE SITUATION CHANGED

There were two important changes in the world's oil situation:

1. The world was using more and more oil. More and more products were made from oil and more and more cars were built. The world came to depend heavily on oil.

2. OPEC (Organization of Petroleum Exporting Countries)

   In 1960 the countries who produced most of the world's oil joined together. They said the big oil companies had not been giving them a fair deal. They said they wanted more money for their oil. They said they wanted to control their own oil. Their governments wanted more money so they could build schools, hospitals and factories.

   The members of OPEC were: Algeria, Iran, Iraq, Kuwait, Libya, Equador, Gabon, Indonesia, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela. Find them on a map of the world. Some of these countries are very small, but they have lots of oil. By the early 1970's, over half of the world's oil came from these countries.

   In 1973 the OPEC countries cut off oil export supplies for six months. They wanted to show the rest of the world how much power they had. They said other countries would have to pay the prices they set or they wouldn't get any oil. This was often called the oil crisis.

Ever since the prices began to rise in 1973, Canadians have been worried that we might run short of oil. Canadians have had to pay high prices for the oil that is brought into Eastern Canada from other countries. The price increases mean that we must pay a lot of money out to other countries. Then this money cannot be used for Canadians.

WE WERE NOT PREPARED

The change in world prices came very quickly. No one was prepared.

Since it had been so cheap to buy oil from other countries, no one had worried much about looking for oil. Oil was used up faster than new oil reserves were being found.

Oil companies had to stop selling so much oil to the United States. Canada had to find more oil.

Oil companies began to search for oil in the North.

NATURAL GAS

Natural gas is found in the same kind of areas as oil. Sometimes natural gas is found by itself. Sometimes it is found with oil.

There is usually lots of natural gas dissolved in oil. When the oil is pumped out of the ground, the gas bubbles out of the oil.

Natural gas takes up a lot of space, because it is a gas, not a liquid like oil. Therefore it is harder to store.

Natural gas can be compressed. (This means it is squeezed together to fit into a small space and is kept under pressure.) Then it can be pumped through a pipeline.

You have probably seen a propane stove in your community. Propane is like natural gas. It is used by releasing the pressure so it flows out, and then lighting it.

Natural gas is used for: cooking; heating buildings; making electricity; and other heat production.

NATURAL GAS IN THE NORTH

A lot of natural gas has been found in the North in the same areas where people have been searching for oil.

The main gas fields found so far are in the Mackenzie Delta and Beaufort Sea and the High Arctic Islands.

OIL AND GAS TRANSPORTATION

There are two main ways that oil and gas could be taken from the Arctic to the south:

1. A pipeline overland

   In the early 1970's, two companies wanted to build a natural gas pipeline along the Mackenzie Valley from the Delta to Alberta. This pipeline was to carry Delta and Beaufort Sea natural gas south.

Justice Thomas Berger was sent by the Canadian Government to ask the people of the north what they thought about building this pipeline. It would be a very big project.

After many months of listening to the people, Justice Berger wrote his report. He said that no pipeline should be built along the Mackenzie for ten years. He said that the Dene land claims should be settled first. Therefore, there has been no gas pipeline built yet in the N.W.T. (1982).

In 1980 hearings were held to decide if an oil pipeline would be built from Norman Wells to Alberta. (See the section on EARP Panels at the end of this unit.)

2. Tankers

A tanker is a very large ship that is specially built to carry liquids. The liquid is pumped into huge compartments that make up the hold of the tanker. A great deal of the world's oil is transported in tankers.

In 1980 it was announced that liquified natural gas could be carried out of the Arctic Islands in tankers. Special tankers would be built.

The problem with natural gas is that it takes up so much space. Therefore it would be chilled before being put into the tankers. When it is chilled enough it becomes a liquid. Then it does not take up so much space and can be carried in a tanker ship.

The tankers would also be icebreakers. The gas would be carried through the Northwest Passage.

Find the Passage on a map. It goes through Barrow Strait, Lancaster Sound, Baffin Bay and Davis Strait.

OIL AND GAS* EXPLORATION IN THE NORTH

NORMAN WELLS: Oil was discovered here before 1920. The oil has been used locally for many years. There is still lots of oil in the Norman Wells area.

PRUDHOE BAY, ALASKA:(part of the United States) In 1967 huge oil deposits were found here. The oil belongs to the U.S.A. This find made the oil companies think they had a good chance of finding oil in the Canadian Arctic.

MACKENZIE DELTA: In 1970 Imperial Oil found oil north of Tuktoyaktuk. There has been quite a lot of oil and gas found in the Delta.

BEAUFORT SEA: In 1972 Imperial Oil built an artificial island in the Beaufort Sea and drilled a well. They didn't find oil in the first place they drilled. So they built another artificial island in 1973-74 and tried again. This time they found oil and gas.

*NOTE: When we talk about gas, we do not mean gasoline. Gasoline is a fuel that is made from oil during the refining process. As you know, gasoline is a liquid. Natural gas is a hydrocarbon fuel that is found in a gaseous state. (See the section on how gas and oil were formed.)

In 1976 Dome Petroleum was given permission to use drillships to search for oil in the Beaufort Sea. Before they were given that permission, they had to prove to the Government that they knew how to operate safely. They had to prove that there was not much chance of an oil spill that could harm the environment.

Since that time, oil and gas have been found in more places in the Beaufort. But, as of fall, 1982, no oil has been taken out of the Beaufort area.

DAVIS STRAIT: In 1979 Esso completed the first well here. Results were poor. In 1980, Aquitaine Company completed a well that they had started a year before. They found some gas. The actual results, as of Fall, 1982, are still known only by the companies who did the drilling.

LANCASTER SOUND: Some oil companies think that there may be a lot of oil in this area. But permission has not yet been given to drill here.

This is an area that is rich in wildlife. About half of the marine birds of Canada's Eastern Arctic migrate, nest, or feed in the Sound. One third of the white whales and 85% of the narwhales of North America use Lancaster Sound or migrate through it. There are many other forms of marine life as well.

Local people get most of their food from the sea.

Drilling in the Sound will be dangerous because of the many icebergs and it is hard to predict their movements.

Companies are now trying to find a good way to track icebergs. When there is fog or blowing snow, no one can see the ice. They must find ways to use radar and radios for tracking them. Drillships must be warned if an iceberg is coming. There must be enough time to disconnect and get out of the way safely.

Oil companies are looking for ways to tow icebergs. They want to be able to change their paths. It would be cheaper for companies to change the path of the bergs than to have to stop drilling every time a berg came close.

Thus, there are still problems to be solved before drilling will be allowed in the Sound.

ARCTIC ISLANDS: Drilling began in the High Arctic Islands before 1970. During the 1970's, more and more wells were drilled with rigs on land or on ice platforms. Huge reserves of natural gas have been found. But, as of 1982, none has been brought out. Over $400 million has been spent on exploration.

A group of companies has been looking into building a gas pipeline across the barren lands. It would transport gas to eastern Canada.

SOUTHWEST N.W.T.: There is drilling in the Fort Liard area. This is, of course, land drilling.

WORKCARD

1. Why are oil companies now searching for oil and gas in the North?
2. What benefits can oil and gas exploration bring to Northern communities?
3. Look at a map. Locate all the areas where oil and gas exploration is going on in the North.
4. How do you think the environment could be damaged by exploration activity?
5. What precautions do you think could be taken to protect the environment when oil and gas exploration are carried on?

INPUT

HOW WERE OIL AND GAS FORMED?

Oil and gas were formed under shallow seas.

1. Plants and animals that lived in the sea died and sank to the sea bottom. Theirbodies built up on the sea bottom.

2. The weight of the water and the thick layers of bottom material created heat and pressure. Over millions of years the heat and pressure changed the organic remains into gas and oil.

   The gas and oil are called Petroleum Hydrocarbons. Carbon is part of the cells of all living things. When carbon burns, it produces energy (light and heat). The carbon in the living things became the carbon in the gas and oil.

   Petroleum hydrocarbons are compounds of hydrogen and carbon.

3. The gas and oil seep slowly upwards through porous rock. Porous means it is like a sponge with tiny holes in it.

4. When the gas and oil meet a layer of impermeable rock (solid rock with no holes in it), they can't go any further. They are trapped. The rock acts like a lid on a trap.

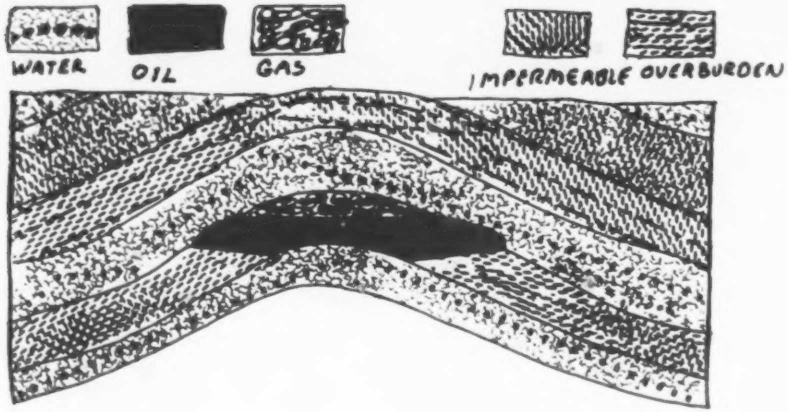
5. The gas, oil, and water settle. Water is the heaviest, so it settles to the lowest part of the trap. Oil is on top of the water, and gas is on top of the oil. (See the diagram.)

   Remember,the gas, oil, and water are in the tiny holes in the porous rock. It is as if they had been soaked up by a sponge. The solid rock is like a lid on the sponge.

6. Over millions of years the rock layers are bent and cracked. If cracks open in the solid rock, the gas and oil move upwards again until they are trapped again.

   Therefore a lot of oil and gas that have been formed in the past have long ago disappeared into the air.

WHERE OIL IS FOUND


WATER
OIL
GAS
IMPERMEABLE OVERBURDEN

Oil, gas and water are in the tiny holes of porous rock.

Porous - like a sponge.

(Reference: Crude Oil in Cold Waters, p. 5)

HOW DO YOU EXPLORE FOR OIL?

The oil companies search for oil and gas caught in traps.

Geologists have learned to look for certain kinds of rocks. They know which kinds of rock might contain oil.

The rocks have to be a certain shape. Geologists have special instruments that send signals down deep into the earth and bounce them back. Their instruments show them the shape of the rocks below the surface. They learn everything they can about the rocks under the surface before they drill.

When the geologists think that they have found a place that might have oil or gas, they put down a test well. If they don't find anything, they go somewhere else to try again.

Most wells are dry. That means they don't hit oil or gas. They usually have to drill quite a few wells before they find oil or gas.

It costs a lot of money to explore for oil and gas. That is why only very big companies can afford to explore.

EXPLORING FOR OIL AND GAS

WORKCARD

1. How can knowing how oil and gas were formed help geologists find it?
2. Why does a company often have to drill several wells before they find oil?
3. Why would scientists expect to find oil and gas under the sea bottom off the N.W.T. coast?

INPUT

DRILLING FOR OIL

On Land: A drilling rig is set up and a deep hole is drilled down through the earth and rock.

When the drill opens a hole in solid rock that is a lid on an oil trap, the oil can be removed through the well. In some wells the oil flows to the surface by itself because it is under pressure. In other wells the oil must be pumped to the surface.

At Sea: The aim of drilling is the same as on land. The oil drillers want to drill through the rock on top of the oil trap and bring the oil to the surface.

The main difference is that there is water between the drilling rig and the solid earth.

Special technology (equipment and methods) has been developed for drilling oil wells under the sea.

1. Artificial Island: An island is made by dredging the sea bottom and piling up sand and other material. Then a land drill rig is set up on the island. Drilling from an artificial island is just like drilling on dry land.

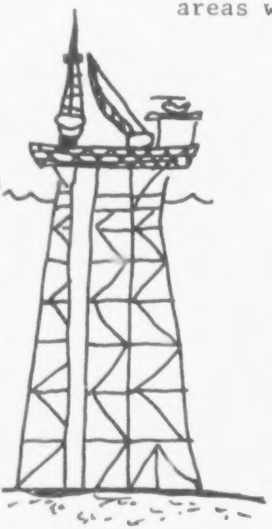
   Artificial islands can only be made in fairly shallow water. They cost a lot to build, and once built, they can't be moved somewhere else.

2. Ice Platform: The natural ice is flooded and thickened layer by layer. Then a land drilling rig is set up on the ice platform.

   Ice platforms are used in the high arctic islands where the ice gets very thick and where there is no ice movement.

   Ice platforms cannot be used in the Beaufort Sea because the ice moves too much there.

3. Drilling Platforms: These are set on or anchored to the sea bottom. The diagram shows three different kinds. They can be used in areas where there is no danger of moving ice.



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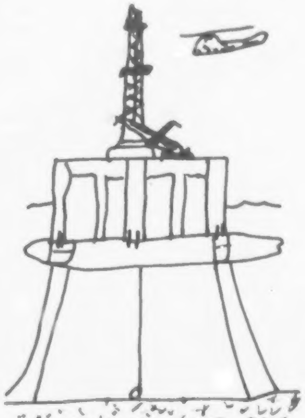
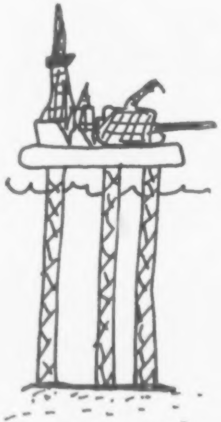


SEMISUBMERSIBLE



JACK-UP.

NOTE: A semisubmersible is not set on the sea bottom, but is half-submerged in water and anchored to the sea bottom by heavy cables.

DRILLING THROUGH THE SEA FLOOR

GLORY HOLE: A large shallow hole dredged in the sea floor before drilling. It protects the BOP stack from ice that scrapes the sea floor.

DRILLING MUD: Is pumped down through the hollow drillstring to lubricate the bit as it turns. The mud is a thick liquid.

The liquid mud removes the rock bits that have been drilled out of the rock. It carries them upward between the drillstring*and the wall of the well.

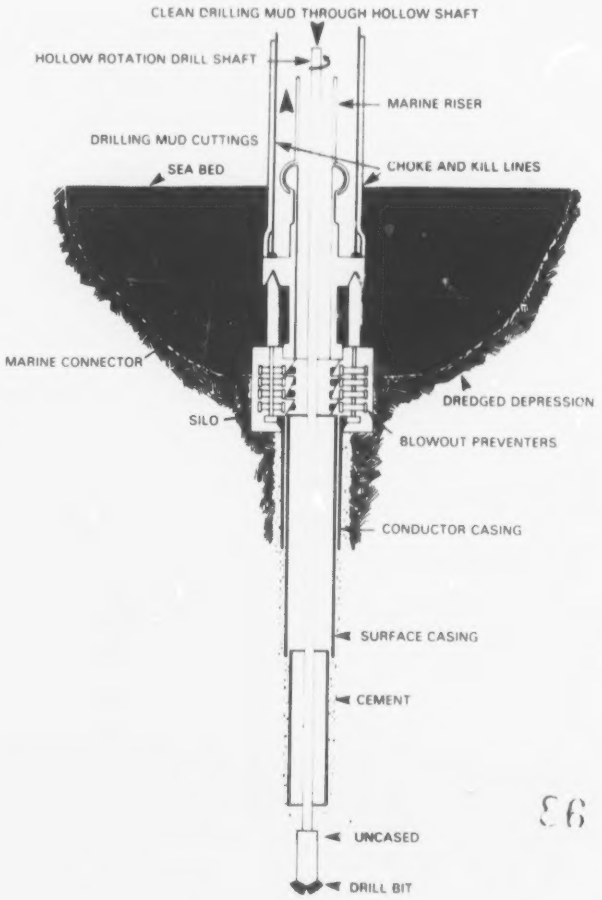
The mud is under pressure to keep water from entering the well.

The drilling mud is checked often to make sure that none of it is seeping out into the rock around the well.

The pressure of the drilling mud is checked often too. If a blowout starts (see the next section) a rise in drilling mud pressure will warn the drillers.

MARINE RISER: The connection between the ship and the top of the well. It can bend and get longer and shorter. This means the ship can drift or rise and sink on the waves without breaking the connections to the well.

*The drillstring is the hollow drillshaft. It consists of sections of hollow pipe that join the drill bit to the drilling machinery on the ship.)

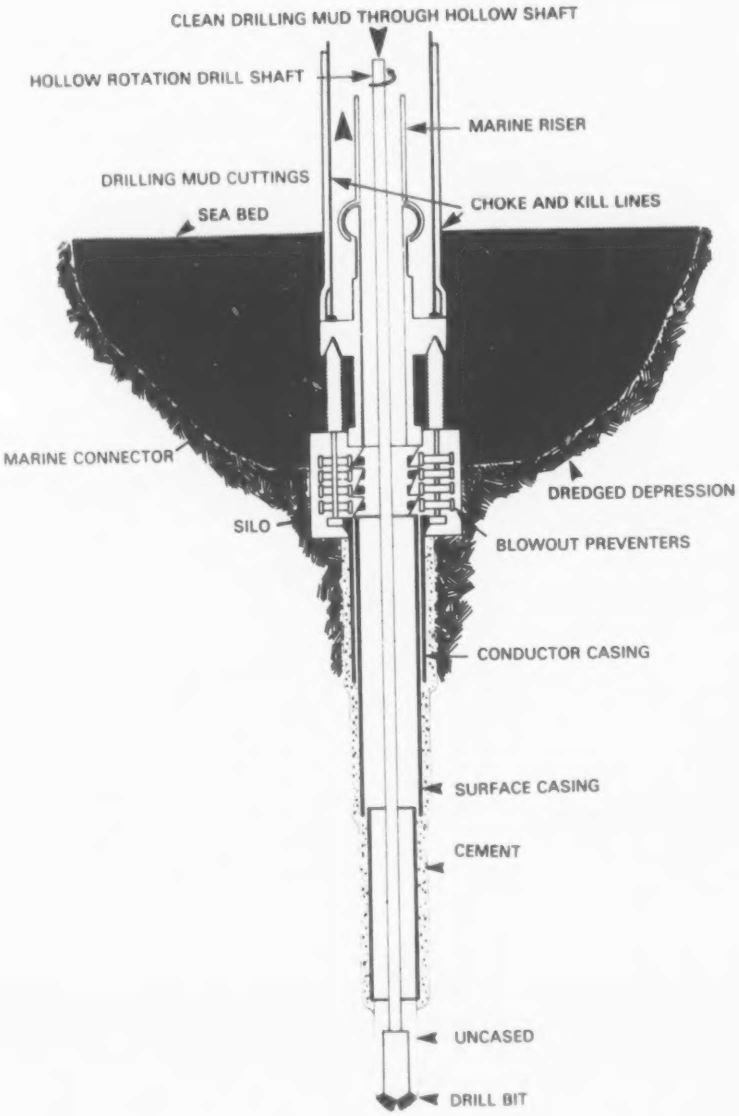

CLEAN DRILLING MUD THROUGH HOLLOW SHAFT
HOLLOW ROTATION DRILL SHAFT
MARINE RISER
DRILLING MUD CUTTINGS
CHOKE AND KILL LINES
SEA BED
MARINE CONNECTOR
DREDGED DEPRESSION
SILO
BLOWOUT PREVENTERS
CONDUCTOR CASING
SURFACE CASING
CEMENT
UNCASED
DRILL BIT

BLOWOUT PREVENTERS: (BOPs) Are powerful safety valves attached to the top of the well casing.

If pressure gets too strong, these can be closed to keep oil and gas from escaping. They can even cut right through the drillstring.*

There are always several BOPs on top of each other. The BOP stack may be ten metres high.

CASING: As the well is drilled, steel casings are cemented into the hole. They are like strong steel pipes. They keep fluids from seeping into or out of the well.


CLEAN DRILLING MUD THROUGH HOLLOW SHAFT
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SEA BED
MARINE CONNECTOR
DREDGED DEPRESSION
SILO
BLOWOUT PREVENTERS
CONDUCTOR CASING
SURFACE CASING
CEMENT
UNCASED
DRILL BIT

WORKCARD

1. What do you think are the advantages and disadvantages of drilling from:

   - an artificial island?
   - an ice platform?
   - a drillship?

INPUT

Most mines are located in areas a long way from big cities. There are not usually many people living in mining areas other than the people who work in the mine.

People used to think that it didn't matter much if mining companies dumped their wastes into waters near the mine. They thought that no one would care because it was only wilderness.

But now people have realized that the environment should be protected now matter how few people live there. Now there are laws to control the amount of waste materials that mines and smelters may put into the environment.

Mining companies now do many things to cut down pollution. But it is still impossible to find a mine that doesn't change the surrounding environment in some way.

WATER POLLUTION

Water is used in many stages of mineral processing. Various chemicals are added to the water. Many of these chemicals are toxic. Toxic metals such as zinc or copper may dissolve in the water when the water is acidic. (See the section on Acid Rain.)

Ground water seeps into mines and must be pumped out. Dissolved minerals can make this water toxic.

Most mines try to remove some of the dangerous materials from the water before they put it into a lake or river. They may use the same water over and over many times before it is discharged. The quality of the water returned to the environment varies from mine to mine. At some mines the water is very polluted and at some it is not bad.

MINE TAILINGS

Tailings are the wastes from mining and processing. Waste water from the mining or milling operations is usually pumped to a tailings pond where the solids settle out. If the tailing ponds are working perfectly, the water will go from one pond to the next, and at each pond some of the solids will settle to the bottom. At the end of the system, clear water will be discharged into a lake or river.

However, a lot of things can go wrong. If there is too much water, the water will overflow or flood and the waste material will be spread around. Water may pass around the side of the dam instead of being held in the pond.

If the bottom of the pond is not properly lined, toxic materials will seep into the ground water.

There are no mines in the North that dump their tailings directly into a body of water.

AIR POLLUTION

The smelting process may release large quantities of sulphur dioxide and metals into the air. These particles are heavier than air and so they fall back to earth. Some fall close to the mine and others are carried a long way on the winds.

The particles may settle like dust, or they may be dissolved in rain or snow and turn water into acid. When you study the section on Acid Rain you will learn that it can damage plant and animal life.

LAND POLLUTION

When a mine is made and when ore is removed and separated from the mineral it contains, there is a great mass of rock, gravel, sand, and other earth material left over. This can look very messy. It can also divert streams, fill marshes, become windblown over a large area and run off into fish spawning beds.

NOISE POLLUTION

Mines and mills use heavy machinery that can be very noisy. The noise can make workers partly deaf. It can bother people who live near the mine, and disturb wildlife.

ABANDONED MINES

When most of the mineral has been removed from a mine, the mine is closed down.

If there are dangerous wastes stored in the mine, these can get into the environment if the mine floods. Old mines often partly fill up with water because they are just a deep hole in the earth. Ground water and rain water get into old mines.

Mercury often gets into rivers and lakes from old mines. (See the section on Mercury.)

Arsenic is a dangerous waste product from the gold mining in Yellowknife. The arsenic is stored underground at Giant Mine. It is pumped to special chambers dug out of bedrock and frozen ground. These chambers are sealed off and separated from the rest of the mine by thick concrete. The concrete is strong enough to hold back any water if the mine floods after it is abandoned in the future. (Con and Giant mines now recover their arsenic for sale.)

Abandoned mines can also be dangerous places for children. They can fall down shafts or get knocked on the head by falling rocks if they play in old mines.

WHAT CAN MINES DO TO REDUCE POLLUTION?

1. Water should be 'recycled' as much as possible. This means that, after the water has been used in processing, the wastes should be removed. Then the same water should be used over again.

2. The water should be as pure as possible when it is put back into the environment.

3. Special equipment should be put in smelters to keep pollutants from going up the smokestack and into the air.

4. The waste rock and gravel should be kept in one area as much as possible. Hills of rock can be planted with grass to make them look nice and reduce leaching.

5. Pits dug for opencut mines can be made into lakes when the mine is closed. People can use these for swimming and boating.

6. Many companies put in special equipment to reduce noise. Otherwise they give the workers hearing protection, such as special ear covers.

7. Underground storage that cannot leak should be built for all dangerous waste material.

THE PROBLEM IS:

Environmental protection of an area around a mine is very expensive business. Mines are big and they produce a lot of waste material.

Sometimes it is cheaper for a mining company to pay the fine than to clean up its pollution.

People who live and work in mining towns often do not want to complain about the mine.

People who do complain about pollution from a mine often forget about the benefits they get from the mining industry.

WORKCARD

1. Many people who live and work in mining towns are bothered by pollution, but don't want to complain about it. Why?

2. There are laws that limit the amount of waste that mines can put into the air or water. Sometimes the mines just keep on paying fines instead of cleaning up. Why do you think they do this?

3. Most mining companies these days are trying to build up a good image. If there is a mine near you, find out what they are doing to keep down pollution.

4. If there is a mine in your area, try to visit it. Is it causing any pollution? How?

5. How can a community near a mine put pressure on a mine to clean up?

6. Any mine is always going to cause some pollution. Why?

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AIR POLLUTION

INPUT

Air is polluted when it contains substances or compounds in sufficient concentrations to cause discomfort and/or harm to living organisms. Pollutants in the air may be gases or tiny particles.

Air pollution can cause disease. Lung cancer can be caused by breathing in polluted air for many years. If you are a smoker and you live in a place with polluted air, you have a very good chance of getting lung cancer, bronchitis or emphysema.

Air pollution can cause other lung diseases as well. When you have a lung disease, it is very hard to breathe. Most lung diseases are very hard to cure.

Air pollution comes from:

- natural sources such as volcanoes, deserts, forest fires, ocean salt.
- trucks and automobiles (over half of the air pollution in big cities comes from vehicles).
- factories, steel mills, ore smelters.
- other buildings.
- incinerators (burning barbage)

Sulphur dioxide is a gas that results from burning fossil fuels containing sulphur and the smelting of ores containing sulphur. A lot of this gas comes from oil and coal-burning plants that produce electricity. You will learn more about it in the section on acid rain.

Carbon monoxide is a dangerous gas that results from incomplete combustion while burning fuel. Large amounts of this gas come from the exhaust pipes of cars and other vehicles. If you breathe in large amounts of carbon monoxide, it keeps your body from getting oxygen. Then you suffocate. Small amounts of this gas can make you very sleepy.

Smoke is made up of tiny particles less than half a millionth of a metre (0.5 microns) in diameter. Soot and dust may be somewhat larger, up to 100 microns in diameter.

Smog is formed when vehicle exhaust fumes mix with smoke and other atmospheric gases in big cities. It is thick and dark and has a bad smell. People can't see very far when there is smog. Their eyes sting, their noses and throats hurt. They may get bad headaches. Some old or sick people can get very ill when there is smog in a city.

Even in the north, air pollution can be a problem. In winter, when it is very cold, lots of people leave their cars running so the motors don't get cold. Then carbon monoxide and other pollutants from the cars' exhausts mix in the air. People have to breathe in the bad air.

People who go to Yellowknife or other big towns from very small places in the winter often complain that the air smells.

There aren't many industries in the north, but the ones we have can pollute the air. Mines can pour a lot of dangerous materials into the air through their smokestacks. You'll learn more about this problem in other sections.

Forest fires can pollute the air.

WHAT CAN YOU DO TO HELP?

Begin by not smoking. Don't pollute the air in your own lungs. Don't pollute the air that other people have to breathe.

Don't leave motors running. Even snomobiles pollute the air.

Don't waste electricity. The generating plant in your town has to burn fuel to produce that electricity.

People should keep their furnaces in good condition. A furnace that isn't working right produces carbon monoxide and other dangerous fumes.

If people in your community burn their garbage beside their houses, convince them that there are better ways. Talk to your community council about the problem.

The Clean Air Act is a law made by the Canadian Government to set limits on the pollutants that can be released into the air. The Clean Air Act was passed to try to create a healthy environment for all Canadians.

KEY WORDS

sulphur dioxide
carbon monoxide
suffocate
lung cancer
incinerator
smog

1. Identify any sources of air pollution in your community.

2. Suggest ways to cut down any air pollution in your community.

3. Why don't we have as many air pollution problems in the north as big cities do?

4. Look at a map of Canada. Locate Ottawa and Hamilton. Ottawa is the capital of Canada. It has a lot of government offices. Most people in Ottawa work for the government. Hamilton is an industrial city. It has a huge steel-making factory. Which city do you think has a bigger air pollution problem - Ottawa or Hamilton? Why?

5. What health problems can be caused by air pollution?

6. Air masses move across our country. Even if we don't pollute our own air, who could pollute the air that we eventually breathe?

7. Look at a map of the Northwest Territories. Locate two settlements that are fairly close together, one of which has a major industry.

   Do you think that the other community may be affected by any possible pollution occurring from that industry? What factors were involved in making your decision?

ACID RAIN

INPUT

Acid rain is a great threat to the environment. It has been called the greatest emergency in the world. It affects areas thousands of kilometres away from crowded, industrial cities. It kills lakes. It slows the growth of forests. It can destroy great wilderness areas. It may eventually be a threat to our northern environment.

Acid rain is precipitation which has mixed with gases and/or particles in the air to form a weak acid. This acid falls on lakes, rivers and forests far from the source of the pollution.

Acid eats away at things it touches. Strong acids can burn your skin and eat away clothing. Acid rain is not as strong, but it builds up in a lake or forest and does its damage slowly.

The substances that mix with rain and snow to make them acid are:

> Sulphur dioxide, which comes mainly from ore smelters and oil and coal-burning power generators.
>
> Nitrogen oxide, which comes mainly from vehicle exhaust.

ACID RAIN KILLS FISH:

- by direct action on the fish. Trout are very sensitive to changes in water acidity. A small increase in acidity can kill trout. In many affected areas, trout and salmon have already been killed off.

- by killing the food supply of fish. Plankton (tiny plants and animals in the water) are killed off quickly. Frogs and insects may die too.

- it interferes with egg development.

- it interferes with young fish (larval) development.

- it helps to release poisonous metals into the water. These metals usually lie harmless in the silt at the bottom of the lake. The acid changes them into a form that is toxic to fish and to humans.

ACID RAIN SLOWS PLANT GROWTH:

It leaches (washes downwards important nutrients (plant food) from the soil. These nutrients are important for normal plant growth.

It slows down decay. Decay, the breaking down of organic matter, is how plants get a lot of their nutrients. This means that not enough nutrients are available to the plants.

It kills earthworms. These keep air spaces open around the plant roots. Roots need air. Without it they die.

It keeps seeds from sprouting.

Scientists are still studying the many ways that acid rain harms plants and animals. Acid rain seems to have its worst effect in spring. Snow melts and washes into lakes and soil. Meltwater carries all the acid that has built up in the snow all winter. There is a sudden increase in acidity in water and soil. This can cause a shock that can kill a lot of fish.

ACID RAIN CAN DO DAMAGE IN TOWNS TOO.

It erodes buildings. That means that it slowly wears them away. Some buildings that have stood for hundreds of years without changing have worn away a lot in the last few years.

Some famous buildings that are being eroded are the Parthenon, in Greece, the Colosseum in Rome, the Taj Mahal in India. If there is an encyclopedia in your school, your teacher might be able to find pictures of these very old and very famous buildings.

It can also damage buildings that are not very old. This happens because the acids can dissolve certain kinds of rocks.

If acid rain gets into drinking water supplies, it can dissolve particles of copper or lead from pipes. If these things get into drinking water it will be toxic. In some places people have to let their water run for a while each morning to get rid of the water that has been poisoned by the pipes.

ACID RAIN KILLS LICHEN

In cities that have heavily polluted air there are no lichens growing any more.

Many animals in the north depend on lichens for their food. In areas where acid rain is falling the lichens may be killed off.

WHAT AREAS HAVE BEEN DAMAGED BY ACID RAIN? WHERE DOES IT COME FROM?

If you have an atlas, you should look at it, or look at a wall map of the world.

The main industrial areas of the world are:

- Northeastern United States and the part of Canada that is just across the border from this area.
- Great Britain, France, Germany, and other countries of Western Europe.
- Japan.
- Parts of U.S.S.R. around Moscow

Lots of other places have industry, but these areas really have a lot of industry. These are the places that produce most of the particles that cause acid rain.

Winds carry the pollutants from these areas north and east. Areas a long way north and east of these industrial areas are suffering from acid rain.

Look at your map again. Try to guess which areas might be suffering from acid rain.

Hundreds of lakes in Ontario have been 'killed' by acid rain. So have lakes and rivers in Quebec, the Maritimes, and northeastern U.S.A. In Sweden and Norway, over 15,000 lakes have been killed. Japan has a problem. Even parts of the Rocky Mountains are suffering from pollutants from west coast cities or from further away.

So far, we have been fairly lucky in the Northwest Territories. Perhaps we wont be so lucky by the time you are married and have children of your own.

However, there is acid precipitation around Yellowknife. This means that pollutants from industry are falling on land and water near Yellowknife. There are no huge smokestacks to carry particles high into the air where they can be carried on the wind. Plant growth and lakes have been affected within 20 km of Yellowknife.

WHY WASN'T ACID RAIN A PROBLEM MANY YEARS AGO? WHY ARE WE SUDDENLY HEARING A LOT ABOUT IT?

1. It used to be that pollutants went up through ordinary short chimneys. The pollutants fell back to the ground close to the places where they came from. But people who lived close to the factories didn't like this. So the factories put in very tall smokestacks. These were so high that the pollutants that came out the top would be swept up by winds high above the ground. They would be carried far away.

   No one thought they would cause a problem where they came down.

   It worked very well for the towns that were getting rid of their air pollution. Take the example of Sudbury, a mining town in Ontario. You look at it on a map. So many pollutants have fallen on the forests around Sudbury for many years that the trees were stunted.

Then a super-tall smokestack was installed to blow the wastes away from the smelter. Now the trees grow taller, the grass is greener, and there are lots of wildflowers in the bush. People don't have to breath in so much bad air.

Sudbury is the largest single source of sulphur dioxide in North America. It gives out 20% of all sulphur dioxide emitted in Canada. (Emitted means given out.)

The sulphur from Sudbury has a lot to do with acid rain that falls on eastern Canada. It has helped to kill many lakes. The smokestack was supposed to prevent pollution. But it made another problem.

Big smokestacks have been built in a lot of other places too. They were built to get rid of pollution in the 1950's and 60's.

In Great Britain, pollutants were mixing with fog to make thick black smog. Sometimes planes could not land. People were getting sick. So, very tall smokestacks were built to clear the air in Britain. Wind carried the pollution to Norway and Sweden. Acid rain killed lakes there.

2. A lot of the electricity that big cities use is made in plants that burn coal and oil. Because oil is becoming very expensive, more and more electric plants are using coal instead of oil. (See the section on the Oil Crisis.)

Most coal used contains a lot of sulphur. When it is burned, the sulphur goes up the chimney. It is this sulphur from electricity plants that is causing much of the problem.

There is better coal in some places. Better coal has less sulphur. But, the trouble is, the good coal costs a lot more, thereby increasing the price of the electricity.

WHAT CAN BE DONE ABOUT ACID RAIN?

1. Try to correct the damage that has been done.

This is very hard to do because the rain keeps falling. In many places people have been putting lime into lakes. This makes the lakes less acid. But they have to keep on adding lime and this is very expensive.

2. Cut down pollution at its source.

This can be done by crushing coal and removing sulphur before it is burned or by putting 'scrubbers' in factories. Scrubbers are special kinds of equipment that take sulphur out of gases before they go up the chimney.

The trouble is, these methods are expensive. Sometimes companies will not use them unless the law forces them to, but many do, because they have to live with the problems too.

3. There must be agreements between countries.

The country that suffers from acid rain may not be the same country that causes it. It is very hard to get agreement on what to do. Each country wants to do what is best for it.

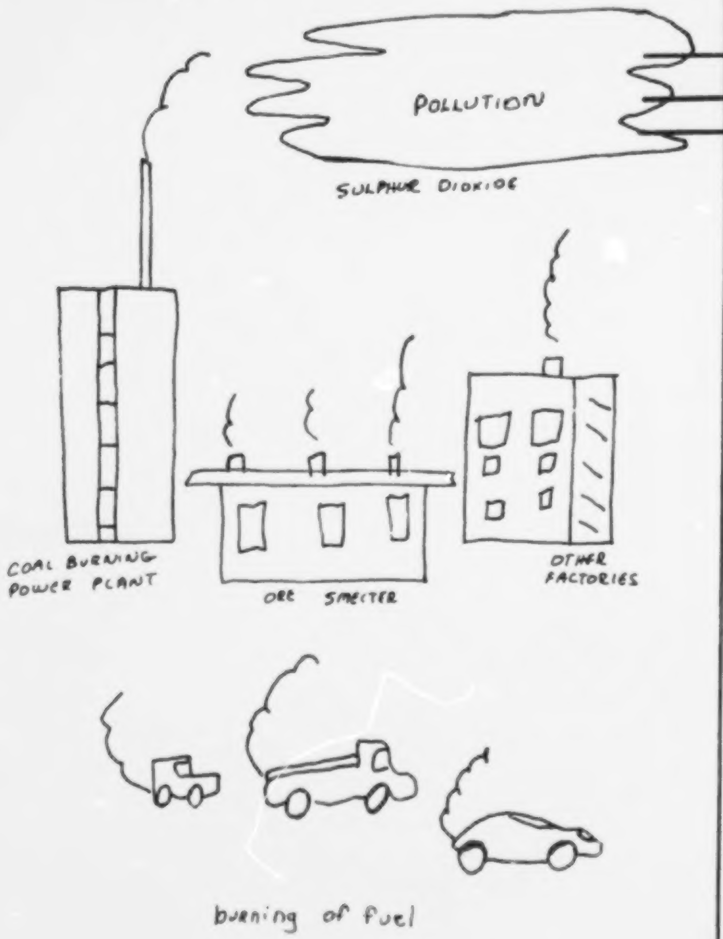
Canadian lakes are being killed by pollution from the United States and vice versa. Both countries must make new laws to stop pollution.

The United States now recognizes that acid rain is a serious threat to the environment. Recently the problem has been recognized and with its recognition, hopefully, agreements can be reached between Canada and the United States which will reduce the pollutants in the air.

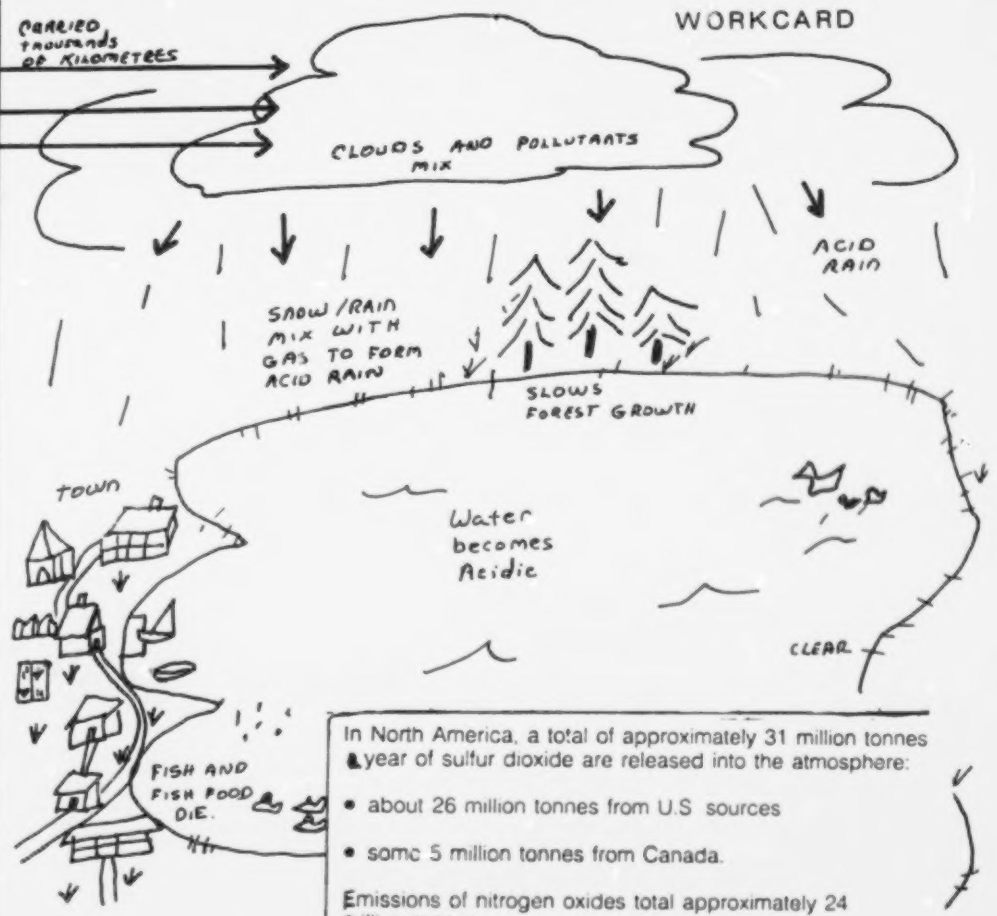
But it takes a long time to come to an agreement. And, while everybody is talking, the problem is getting worse.

KEY WORDS

acid
sulphur dioxide
coal-burning generator
nitrogen oxide
precipitation
leach
erode
scrubbers


POLLUTION
SULPHUR DIOXIDE
COAL BURNING POWER PLANT
ORE SMELTER
OTHER FACTORIES
burning of fuel

WORKCARD


CARRIED thousands of KILOMETRES
CLOUDS AND POLLUTANTS MIX
ACID RAIN
SNOW/RAIN MIX WITH GAS TO FORM ACID RAIN
SLOWS FOREST GROWTH
TOWN
Water becomes Acidic
CLEAR
FISH AND FISH FOOD DIE.

In North America, a total of approximately 31 million tonnes a year of sulfur dioxide are released into the atmosphere:

- about 26 million tonnes from U.S sources
- some 5 million tonnes from Canada.

Emissions of nitrogen oxides total approximately 24 million tonnes:

- the U.S. accounts for about 22 million tonnes a year
- in Canada, it's about 2 million tonnes.

WORKCARD

1. Look at a map of Canada. The main industrial areas are in southern Ontario and Quebec. Winds in the N.W.T. blow mainly from the west or northeast. Why hasn't the N.W.T. been affected by acid rain yet?
2. Which parts of the N.W.T. are most likely to be affected first? Why?
3. Acid rain kills lichens. What would happen if our lichens were wiped out in the north?
4. What would happen if acid rain fell on your area? List all the bad things that would happen. Who would be affected the most in your community.
5. How might acid rain in Ontario and Quebec be good for the tourist industry in the N.W.T.? Should we be happy that good sports fishing is being wiped out in Ontario and Quebec?
6. Why is pollution very hard to control when it is produced in one country and affects another?

Some publications you can send for are called

a) Acid rain - The forecast for Western Canada
b) Downwind - The acid rain story

These are available from:

Environment Canada
901, 9942-108 Street
EDMONTON, ALBERTA
T5K 2J5

Another publication entitled

"The Case Against the Rain"

is available from:

Information Services Branch
Ontario Ministry of the Environment
135 St. Clair Avenue West
TORONTO, ONTARIO
M4V 1P5

ARSENIC

INPUT

Arsenic is a toxic substance that used to be popular with murderers and with writers of murder stories. In large doses arsenic is fatal. In smaller doses it is also dangerous.

Arsenic is used in paints, medicines, lead and copper alloys (an alloy is a mixture of different metals), pesticides, weed killers, wood preservatives, hide tanning, and in various chemical, metal, and glass industries.

Arsenic reaches rivers, lakes, and oceans from industries that use it or that produce it as a waste material. It also gets into the air during smelting of some kinds of materials.

Almost half of the arsenic in the Canadian environment comes from gold mining. Much gold ore contains arsenic. After the gold has been processed, there is a lot of arsenic left over. Arsenic gets into the air and into the water near gold mines.

Arsenic is a natural element that is normally found in the environment in low concentrations. It only becomes a problem when the concentration becomes unnaturally high.

Arsenic may enter the human body in food, water, or air.

Arsenic taken into the body in large amounts causes stomach and intestinal bleeding, dehydration, (drying out) and damage to the nerves.

Long term exposure can cause skin disorders, cancers, and respiratory disorders. Cancer caused by exposure to arsenic may take from 20 to 50 years to develop.

Arsenic in some forms stays in the body for a long time. In other forms it passes through the body with little effect.

Therefore, when humans take in arsenic in food (e.g. fish), or in drinking water, some passes through the body, and some stays. The longer a person is exposed to it, and the greater the doses, the greater the chance of being harmed by it.

The effects of arsenic on the human body are still being studied. We don't know what all the effects of arsenic are. Scientists do not agree on all the effects it has on the body.

They do agree, though, that it is very dangerous and should be avoided as much as possible.

Arsenic is fairly persistent in water. This means that it remains in the water for quite a long time.

Arsenic is more toxic to plants than to animals.

Arsenic is stored in the tissues of fish. The more arsenic in the water, the more arsenic there will be in the fish. However, it does not seem to build up in fish the way mercury does.

Scientists still don't know very much about the effects of arsenic on aquatic life. It seems to affect different forms of life in different ways.

The Canadian Government has set limits on the arsenic levels that are allowed in public drinking water supplies. The level is set at 0.05 mg/L. As far as scientists know, this is a safe level. Safe means that that amount will probably be eliminated by the human body with no long term damage.

Some scientists disagree. Some say the level has been set too high.

ARSENIC IN YELLOWKNIFE

There are two gold mines in Yellowknife; Giant Mine and Con Mine. They provide a lot of jobs. In the past, they have also provided a lot of arsenic.

The gold ore contains a lot of arsenic. After the gold has been removed from the ore, the arsenic must be disposed.

For many years, a lot of that arsenic was poured into the air through the chimneys. Airborne arsenic spread over trees, plants, land, water, and snow. People breathed in that air. There was arsenic in fish, in drinking water, in tea made from snow in the bush, on vegetables grown in summer gardens.

Arsenic also got into the environment through the tailings ponds. Arsenic particles that were not removed during the settling process ended up in local lakes and in Great Slave Lake.

In the last few years there has been a lot of publicity about the danger of exposing the people in Yellowknife to arsenic. As a result, the mines have been putting in new equipment to collect arsenic before it gets into the environment. They are now putting far less arsenic into the air and water than they used to. The arsenic levels around Yellowknife have decreased significantly.

WHAT ARE THE RESULTS OF ARSENIC IN THE YELLOWKNIFE ENVIRONMENT?

It is impossible to track down all the results because not enough records have been kept. For many years people did not understand the dangers of arsenic. Many other people did not want to admit that there was a problem.

There are some effects recorded:

In 1949 two men working near Giant Mine were sent to hospital with arsenic poisoning caused by drinking snow water.

In 1949 a herd of cattle brought to Yellowknife to produce milk was wiped out by arsenic poisoning. The arsenic came from plants and water.

After these events, a long series of investigations was begun. Studies were done in 1955, 1966-69, and 1977.

In the 1966-69 study, it was found that most of the time the Yellowknife drinking water contained far too much arsenic to be safe.

In 1969 a pipeline costing about $1 million was built to bring water from the Yellowknife River to the city. The river is upstream and away from the mines.

In 1974 signs were posted around Yellowknife Bay warning that drinking the water could be dangerous to health.

Hair sample studies have been carried out by Health & Welfare Canada (the Health section of the Canadian Government) and by the National Indian Brotherhood. People who have been taking arsenic into their body have arsenic in their hair. Samples of hair can be sent to scientists who can test the hair to find out if there is arsenic in it.

Smelter workers were found to have high arsenic hair levels, so were some Dene.

In spite of all the studies, no one could agree on how badly the arsenic was affecting the people of Yellowknife.

Yellowknife has a high cancer rate compared with the Canadian average, but because the population is small and the number of cancer deaths is small, these numbers can't be used to prove anything.

Most of the people who have worked in the mines have left the N.W.T., so no one can find out what has happened to them.

No one is even sure how much arsenic has been getting into the environment around Yellowknife. Samples of underground water near Giant Mine have, in the last few years, shown very high levels of arsenic.

In 1977 a report from the Canadian Public Health Association said that far less arsenic should be put into the environment around Yellowknife.

That report said that "*Indian people and particuculary Indian children are acquiring an increased arsenic load.*"

Children breathe in more air in proportion to their size than adults. Children play in the dust and put their fingers in their mouths.

Since the 1977 Report, Giant has improved its pollution control. There is far less arsenic going into the air than there used to be. They have also improved their tailings ponds so that less arsenic is getting into Great Slave Lake.

WHAT WILL HAPPEN TO THE LEFTOVER ARSENIC IN THE FUTURE?

The leftover arsenic is stored underground in unused sections of the gold mines. Storage chambers in rock and frozen ground are sealed with concrete. Giant claims that their arsenic storage is safe and that the arsenic can never get into the environment.

However, the mine will only be worked for a few more years. When most of the gold is gone, or when the price of gold falls, the mine will be closed down.

Once the mine is not used any more, ground water may get into the storage vault. The vault may develop cracks, and, if water gets in, arsenic may escape.

THE PROBLEM IS:

No one can predict the future perfectly. Even the smartest scientists have been wrong sometimes when they try to predict the future.

WORKCARD

1. Why would Dene in the Yellowknife area have higher arsenic levels than non-Dene?

2. Why is it hard to keep track of health problems of people who work in Yellowknife mines?

3. Why is it hard to prove that arsenic around Yellowknife has done any serious damage? Why are Yellowknife cancer statistics meaningless?

4. What if the two mines in Yellowknife suddenly closed down. How would it affect:

   - store owners?
   - businesses?
   - home owners?
   - anyone else?

5. Why doesn't the government just make a law to force the mines to stop putting arsenic into the environment?

6. Many people who live in Yellowknife don't want to know about the arsenic problem. They keep saying it has all been cleaned up. They don't want to know that there is far more arsenic going into their environment every day than there should be.

   Suggest reasons for this attitude.

MERCURY

INPUT

Mercury is a very toxic metal. There is mercury in many Canadian waters, even where there is no industry.

There is mercury in fish in some parts of the North. If you want to know what mercury looks like, look at a nurse's thermometer. The silver colored part is mercury. It is a liquid at room temperature.

Mercury is found in industry in paints, batteries, switches, fluorescent lights, pulp and paper mills, medical and dental supplies, scientific instruments and more.

Small amounts of mercury are carried in waste water from factories. Some is released into the air when fuels containing mercury are burned. It is carried to earth by rain.

Mercury is found naturally in the environment. It leaches out of rocks and is carried into lakes and streams and settles in ground water.

Most mercury is in inorganic form. That means that it is not absorbed by living things. When inorganic mercury enters a lake, it quickly becomes part of the bottom sediments. It is not dissolved in the water.

However, certain organisms in water convert inorganic mercury (which is harmless) into methylmercury, which is organic mercury. That means that it can be absorbed by living things.

Organic mercury is highly toxic.

Fish and other aquatic creatures accumulate methylmercury in their bodies. Some of this mercury comes directly from the water. Much of it comes from the food they eat.

Mercury bioaccumulates. It builds up in living things. It is not eliminated from the bodies of living things.

For example, a trout is a carnivorous fish. It eats other fish. The mercury that is in the small fish becomes part of the body of the big fish that eats them. The older the trout is, the more fish he has eaten and therefore the greater the amount of mercury that his body contains.

In 1970 it was found that fish in Lake St. Clair in Ontario had dangerous amounts of mercury in their bodies.

After that fish and water samples were taken all over Canada and the United States. It was found that fish in many places had too much mercury in their bodies. Many lakes were found to be polluted with mercury.

Many new laws were made to protect people from mercury intake. People were warned against eating fish in polluted lakes. Controls were put on pulp and paper and chemical industries that were major polluters.

Mercury is very toxic to humans. People who eat a lot of fish that contains mercury can have the mercury build up in their bodies.

Methylmercury is carried through the body by the red blood cells. It can cause brain damage, paralysis, loss of sight or hearing, coma, or even death.

Most damage to humans has come from eating fish. However, in some places children have suffered brain damage from eating meat from farm animals that ate seeds treated with mercury. Seed used to be treated with mercury to keep fungi from growing on them. This is not allowed in Canada.

MINAMATA: THE MOST FAMOUS CASE OF MERCURY POISONING

Perhaps the most famous case of mercury poisoning occurred in Japan in the late 1950's.

At that time not very much was known about the long term effects of mercury. No one was very worried because most of the mercury was inorganic. Therefore no one thought much of it could get into food supplies.

Scientists did know that organic mercury was toxic to humans, but there seemed to be very little of that kind of mercury around.

But in the late 1950's, about a hundred and ten persons who ate large amounts of fish from Minamata Bay in Japan became very sick from mercury poisoning. Forty-three died and the others were left permanently disabled. Their nervous systems were damaged. They became very shaky. They couldn't coordinate movements of their hands or limbs very well.

Scientists found that a chemical plant in Minamata Bay had released small amounts of organic mercury into the Bay and this had built up in the fish. Japanese people eat a lot of fish. The mercury built up in their bodies and caused all that damage.

Since that time the effects of mercury poisoning have been called Minamata disease.

MERCURY IN NORTHERN ONTARIO

Small amounts of mercury are discharged daily into the waters close to all the province's pulp and paper mills. Fish in these polluted rivers have very high mercury levels. Many native people in the area depend on fish for food and also for employment as guides in the tourist lodges. Since several persons have shown symptoms of minimata disease, the authorities have strongly advised against the harvesting of any fish in that area. This has created a severe loss of food supply for many people and the closure of many tourist fishing lodges.

MERCURY IN THE N.W.T.

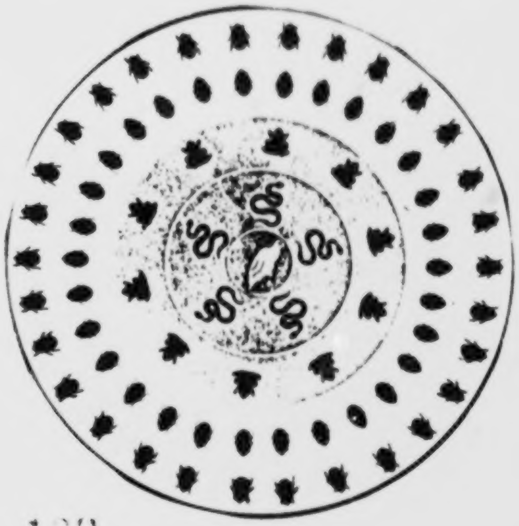
Much of the N.W.T. is part of the Canadian Shield. This means that the rock is very old and hard and contains a lot of minerals. There is mercury in this rock in some places. Many of the natural deposits of mercury have probably not yet been discovered in the N.W.T.

Mercury from natural deposits can get into lakes and rivers, so there are probably many lakes and rivers in the North that contain quite a bit of mercury. Of course, most of this mercury is inorganic and therefore can't get into the fish.

Mercury has been found in several Arctic areas far from industry, including northern Baffin Island. Scientists who work for the Canadian Government have been testing fish from all over the North. As soon as they find any mercury that might be dangerous, they warn the people who live in those areas.

HOW MERCURY BIOACCUMULATES

(From Environmentally Yours, page 12)



The mercury in the insects accumulates in the frog when it eats the insects. The mercury in the frog accumulates in the snake when it eats the frog.

Then the eagle eats the snake. Thus the eagle's body will accumulate a large portion of the mercury that was in the insects.

KEY WORDS

toxic metal
inorganic mercury
organic mercury
bioaccumulate
carnivorous
concentration
paralysis
Minimata disease
methylmercury

WORKCARD

1. What is the difference between organic and inorganic mercury?

2. In many places people have been told that they can eat small fish but not big ones. Explain why.

3. Why have native people been more affected by mercury than any other group of Canadians?

4. Imagine you are a health inspector in a little town in northern Ontario. The area around the town is rock and bush, just like most of the western N.W.T. People get a lot of their food from hunting and fishing.

   The only jobs are in the pulp and paper industry or in the toursit industry. Your area is famous for its good fishing and tourists come from far away to catch the big trout and pike.

   You have just read a secret report. It says that there are dangerous amounts of mercury in the fish in your area. The mercury is coming from the pulp and paper mill. You must decide what to do.

   You can keep the report a secret.
   You can close the pulp and paper mill.
   You can tell people to stop eating the fish.
   You can say that the study was no good and order another one.

   What are the good and bad results of each line of action?

   What would YOU do if you were the health inspector? Give reasons.

5. The law sets 'allowable levels' on the amount of mercury an industry is allowed to put into air and water. What is the problem with having 'allowable levels' for mercury?

6. Have fish in your area been tested for mercury? What were the results? Try to find out. Ask the health people. Ask your community council. Write to Environment Canada, Environmental Protection Service, Yellowknife, N.W.T. and ask how you can find out.

INPUT

CHEMICALS

There are many different substances in the world. Scientists have learned to break these into their basic parts. Then they put the parts together in new ways to make new substances. These new substances are called chemicals. Chemicals are used in many different industries and there are thousands of different chemicals in use today.

Some of the industries that use chemicals are those that make:

- paints and dyes.
- synthetic fabrics (these are fabrics that are man-made. They do not come from animals or plants like cotton or wool. Nylon and polyester are synthetic fabrics.)
- electronic equipment
- cosmetics (make-up, hair spray, perfume)
- metal products
- plastics
- cleaning materials (detergents, bleach)
- printed materials (books, newspapers, photos)
- pesticides and herbicides to kill insects and weeds.

There are many more industries that use chemicals. If you read the labels on things you buy at the store, you will learn that most of these have chemicals in them.

There are even some chemicals used in food to keep it from spoiling. These chemicals are tested to make sure that they are safe. There are laws to protect the health of people who buy food in Canada.

HAZARDOUS MATERIALS

Hazardous means dangerous. Materials are dangerous if they are:

Flammable - catch on fire easily.
Corrosive - wear away metal or other material they touch.
Explosive - when their fumes mix with air, even a tiny spark can set off an explosion.
Reactive - combine with other substances in new and dangerous forms.
Persistent - do not break down in nature.
Toxic - poisonous.
Carcinogenic - cause cancer. A substance that causes cancer is called a carcinogen.
Allergenic- causes allergies. People may get a rash or sore eyes or itchy skin or worse.

HAZARDOUS WASTES

After dangerous chemicals have been used, they are often of no further use. Sometimes these materials can be recycled. This means that they can be purified so that they can be used again. However, it is often very expensive to recycle chemicals.

Therefore, dangerous chemicals are often thrown away. The trouble is, they may be a danger to human health and to the environment.

When dangerous materials are no longer useful and are to be thrown away, they are called hazardous wastes.

HAZARDOUS WASTES ARE HARD TO GET RID OF

Petro-chemicals (chemicals made from oil) decay very slowly when they are attacked by bacteria, sun, wind and water. The natural forces can break them down, but it may take thousands of years.

Nature can purify sewage, but the natural cycle does not remove chemical wastes from water or soil. (See the section on Sewage.)

These chemicals have names like trichloroethylene, tetrachloroethylene, polychlorinated biphenyls. Don't bother trying to learn these names, but you might have some fun trying to pronounce them.) If you look at a few labels on things like paint or battery acid you might find some names that look as strange as these.

Some chemicals are a big problem because it is very hard to get rid of them. If they are put into town dumps or washed down the drain, they get into the environment. If they are poured out onto the ground they get into the soil and water.

Even very small amounts of some of these materials can endanger human health. When these wastes get into food, water, or soil, people can get sick or even die.

Hazardous wastes have been getting into the environment for many years in parts of North America. Nobody even knows where all those chemicals are.

Since people didn't know how dangerous or how difficult these things were to get rid of, people didn't keep track of where they went. There weren't enough laws to control where they went. Many companies put their waste into safe pits where it couldn't leak. But others dumped it into leaky burial pits, or took it to town dumps.

So, these wastes have turned up in strange places. Ponds and marshes around some cities are full of poisonous liquids. Sometimes ponds create so many vapours that people nearby have difficulty breathing. Sometimes these ponds even catch on fire. Many of the drums they were stored in have corroded and the poisons have leaked out into the environment. Now someone has to figure out how to clean up the mess.

GETTING RID OF HAZARDOUS WASTES

Hazardous wastes must be:

- recycled to be used again (see above.)
- destroyed completely. Some materials can be destroyed in special incinerators that burn them at very high temperatures. These incinerators are expensive.
- changed so that they are harmless. (Often not possible, or else very expensive.)
- stored safely until better ways are found to get rid of them safely.
- stored permanently in a safe way.

The problem is that man's knowledge is changing very rapidly. Knowledge about how to make things often changes faster than knowledge about long-term effects.

If you are going to make and use something today, you can only try to predict the long-term results. What is considered safe today may not be safe in twenty years.

These chemicals can last almost forever. That is a long time to plan ahead.

Consider that most of these chemicals have only been around for a few years. That means that they have not been studied or tested for very long.

TRANSPORTATION

Even the transportation of dangerous chemicals is a problem. Many trucks and trains carrying them have been in accidents. In Toronto a train that was carrying chlorine had an accident. Chlorine is used to kill germs in your drinking water. If lots of chlorine gas gets into the air, it can kill people.

A tank car carrying propane on the train exploded and was burning. There was a danger that the chlorine on the train would escape into the air. Thousands of people who lived in that area had to leave their homes. They stayed away for a few days until the danger passed. If the chlorine had escaped while they were sleeping in their homes, they might have been killed.

There have been other accidents in other places. People had to be evacuated. That means they had to be moved out of their homes to a safe place very quickly.

THE LOVE CANAL - A TRUE STORY

In the late 1800's, William T. Love began building a canal in Niagara Falls, U.S.A. to join Lake Erie and Lake Ontario and to provide DC electrical power to industries which needed to cluster close to the electrical supply.

With the development of AC electricity, which could be delivered over great distances, industries spread out and the usefulness of the Love Canal was lost.

The canal, 1.5 km long and 15 m wide, dug into the heavy clay of the Niagara Peninsula, was purchased by the Hooker Chemical and Plastics Company. Over a period of years they dumped about 20 000 tonnes of chemical waste into the canal, sealed in 450 litre steel drums.

The waste was covered with a thick clay cap which was domed about 2 m higher than the surrounding flat land to prevent water seeping into the chemical storage.

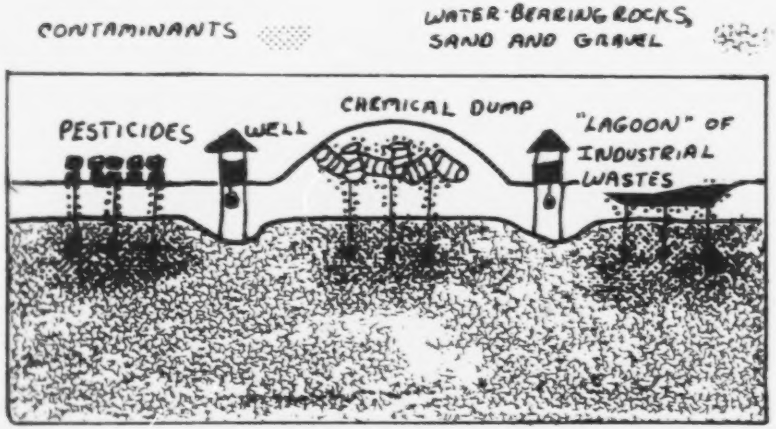
In 1953 the local school board wanted to buy the land for a new building. The school board threatened expropriation. Hooker placed a warning on the deed of transfer and agreed to sell the land for only one dollar.

The school board cleared away the clay cap and built their school only a metre above the chemical waste. Surface water seeped into the dump, corroded the steel drums and formed ponds and puddles of toxic water. Children dug up phosphorus "fire rocks" and people saw "strange lights" over the area at night.

Meanwhile, in the houses surrounding the school, chemicals were seeping into basements and there was a serious outbreak of sickness. Some people developed cancer, women had miscarriages and many children had birth defects.

By 1978 enough clay covering had washed away to reveal that over 80 different chemicals were in the old canal. Some, like PCB's, were highly toxic. Some were carcinogenic, and others caused anaemia, loss of hair, rashes, and other illnesses.

Throughout 1979 and 1980, the government helped relocate a total of 949 families. An inquiry into the whole situation revealed that there were many more chemical dumps, besides the Love Canal, in the surrounding area. The final outcome of all the problems is still being argued in court.


CONTAMINANTS ▨
WATER-BEARING ROCKS, SAND AND GRAVEL ▨
PESTICIDES
WELL
CHEMICAL DUMP
"LAGOON" OF INDUSTRIAL WASTES

GROUND WATER POLLUTION

There is far more ground water than there is fresh surface water in lakes, streams and rivers.

If ground water becomes polluted, it is almost impossible to clean up. Ground water is not exposed to sunlight or air. It does not evaporate and leave dissolved chemicals behind. It travels so slowly through the earth that it cannot clean itself as it flows. In the past, ground water did not become polluted, because the soil at the earth's surface filtered out bacteria and other materials.

But this filtering soil could never remove most chemicals. They dissolve in the water. Filters can only remove insoluble materials, that is, material that does not dissolve.

Once drinking water supplies are polluted with chemicals, people have to look for new drinking water. They won't be able to get rid of the chemicals for many years.

The kind of organic wastes you find in sewage are different. They can easily be filtered out. But it is often hard to even find out if there are chemicals in drinking water. Some of the tests are difficult to perform.

Chemicals get into the ground water from fields that have been sprayed. Chemicals also come from waste left in dumps. Chemicals leak out of ponds used to hold industrial waste.

Once the chemicals are in the ground, each rainfall spreads them further and carries them down into the ground water or into lakes and rivers.

In some American cities people can only drink bottled water that is delivered to their homes.

KEY WORDS

chemicals
synthetic fabrics
pesticides
herbicides
hazardous
flammable

corrosive
explosive
reactive
persistent
toxic
carcinogenic

carcinogen
allergenic
allergy
recycle
purify
petro-chemicals

decay
predict
long-term effects
evacuate
phosphorous
PCBs
filter

cancer
genetic damage
miscarriage
insoluble
filter
ground water
occupational factors

WORKCARD

1. Why do we have few problems with hazardous wastes in the North?

2. Read the labels on lots of different products. Look at cleaning products, oil, grease, battery acid, spray cans, photo chemicals, glue, paint, etc. Which ones have warnings? What do the warnings say? Copy down the names of some of the chemicals. Fill in a chart like this in your notebook.

PRODUCT	WARNING	CHEMICAL NAME

3. Can any dangerous materials get into the environment around your community? Find out:

   - what a garage does with waste battery acid, old oil, and other wastes.
   - who has a darkroom for photography and what they do with their chemicals.
   - if fuel is spilled anywhere.
   - what is done with leftover paint, turpentine, glue, etc.
   - if any insect-killing chemicals are used.
   - what is done with any other dangerous materials after they are used.

   Is there anything wrong with the way people are dumping any of these materials in your community? Are there better ways to get rid of them?

4. Is there a mine or any other industry near you. Find out if they use any dangerous materials. How do they get rid of them?

5. Some kids sniff or drink dangerous materials. This can damage their lungs or do brain damage that can never be repaired. Make posters to warn kids about the dangers of sniffing. Put the posters up around your school.

INPUT

HOW COULD OIL GET INTO THE MARINE ENVIRONMENT?

1. A big oil tanker is wrecked at sea and its load of oil spills out.

   This has happened in many places in the world. The spilled oil has killed fish and seabirds and polluted beaches. It is very hard to clean up. The oil stays on the beaches for many years.

   There are no oil tankers operating yet in the Arctic. But there might be someday.

   In 1969 an American tanker called the Manhattan battered her way through the Northwest Passage from the eastern U.S.A. to Prudhoe Bay in Alaska. A Canadian icebreaker helped her.

   The voyage of the Manhattan was supposed to prove that it was possible to ship oil across the Arctic in tankers.

   The Manhattan did make it home.

   But, before it got home, ice had ripped a six-metre long gash in its hull.

   The Manhattan voyage has led to a new design for icebreaking tankers.

2. A blowout occurs when pressure builds up in an oil well and the well can't be controlled.

   Oil and gas flow up the drill hole to the surface or escape from the wellhead on the sea floor into the water. Or the oil and gas might squeeze through cracks in the rock beside the well. Then the oil and gas might get into the sea through cracks in the sea floor.

   Once the drillers have lost control of the oil flow, a lot of oil could escape into the environment.

   The amount that escapes depends on how much oil there is in the well and on how much pressure is acting on it. It also depends on how fast the oil workers can get the blowout stopped.

CRUDE OIL AND POLLUTION

Crude oil can do a lot of damage if it gets into the environment.

There are still lots of things that scientists don't know about oil in the environment. They are still learning about it. But these are some of the things that they do know:

1. Crude oil is toxic. It contains materials that will dissolve in sea water and are poisonous to living things.

   It also contains sulphur, acids, and heavy metals. The metals such as nickel, mercury, lead and cadmium bioaccumulate. (If you forgot what this means, check the section on Mercury.)

   If these metals get into fish and seals and other human food, it would mean that people could be harmed.

2. Zooplankton, the tiny animals of the sea, are easily poisoned by the parts of oil that dissolve in sea water.

3. Bottom-dwellers (benthic organisms) are slowly poisoned when oil sinks to the sea floor. This happens in areas where the water looks muddy. The silt mixes with the oil to make blobs that sink.

4. Seabirds die when oil gets into their feathers. Their downy inner feathers get stuck down and don't keep them warm any more. Then they die from the cold.

5. Dark oil washed onto the shore would melt the permafrost. (See more about this in the section on the Pipeline.)

6. Wildlife could be harmed. It would depend on where the oil was spilled and how far it spread.

   - White whales have their calves where warm river waters flow into the sea.
   - Caribou and reindeer use some shoreline areas for calving.

   - Many waterfowl use the Mackenzie Delta and lagoons for nesting and staging (see the section on Birds.)
   - Many fish spawn in waters where salt and fresh waters come together.
   - Polar bears and seals live on the edge of the pack ice.

7. Most types of shoreline would be almost impossible to clean up. If a large amount of spilled oil were washed onto a shoreline, it could poison that shore for many years.

8. If it got into the moving pack ice, it would spread over a wide area. It would be very difficult to clean up. (See the section on Oil and Sea Ice.)

A BLOWOUT IN OPEN WATER

(5) A ring of waves around the bubbles at first keeps the oil from spreading.

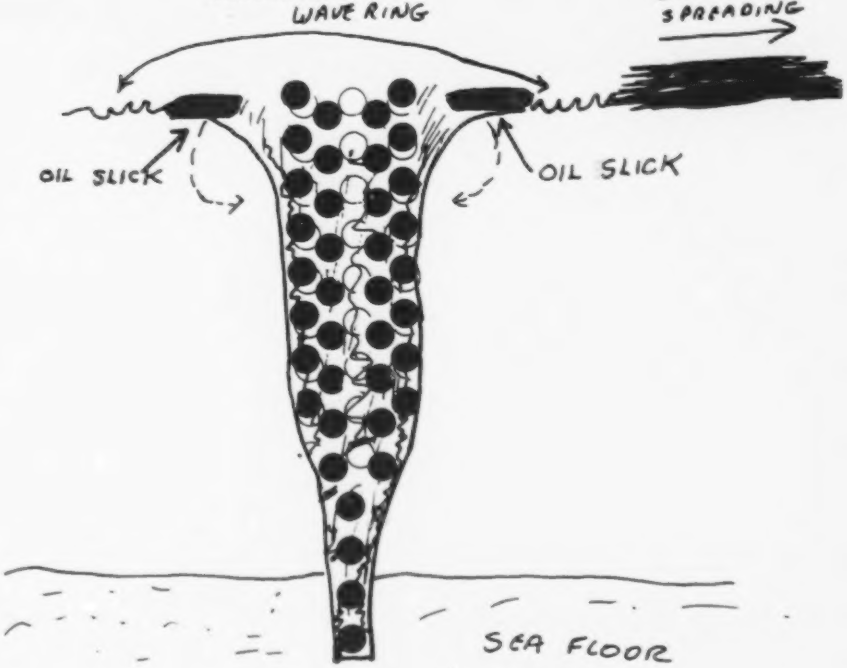
(4) At the surface the oil droplets join to form a slick. The slick floats on top of the water.

(3) As the gas rises it separates from the oil. The gas breaks the oil up into droplets and carries them to the surface.

(2) Gas expands as it rises because there is less pressure squeezing it.

(1) A cloud of oil mixed with gas bubbles flows upward from a hole or gap in the sea floor.

(6) As more oil piles up, it escapes from the wave ring. Then it spreads out and drifts with the waves and currents.



THE FATE OF SPILLED OIL:

Wind speed will determine how fast the slick will spread.

Wind direction will determine whether the oil is driven on shore or out to sea.

Waves break up the slick into droplets that drift under the waves. This may cause more oil to dissolve in the water.

Waves in shallow water stir up the bottom sediments. Oil droplets stick to bits of salt and then sink to the bottom.

Evaporation causes oil to become thicker. The slicks shrink and break up. The oil becomes heavy oil patches and lumps. Later these turn into tar balls that may become heavy enough to sink.

Different types of oil have different densities. Some spread more easily than others. They contain different materials. This affects how they spre dissolve and evaporate.

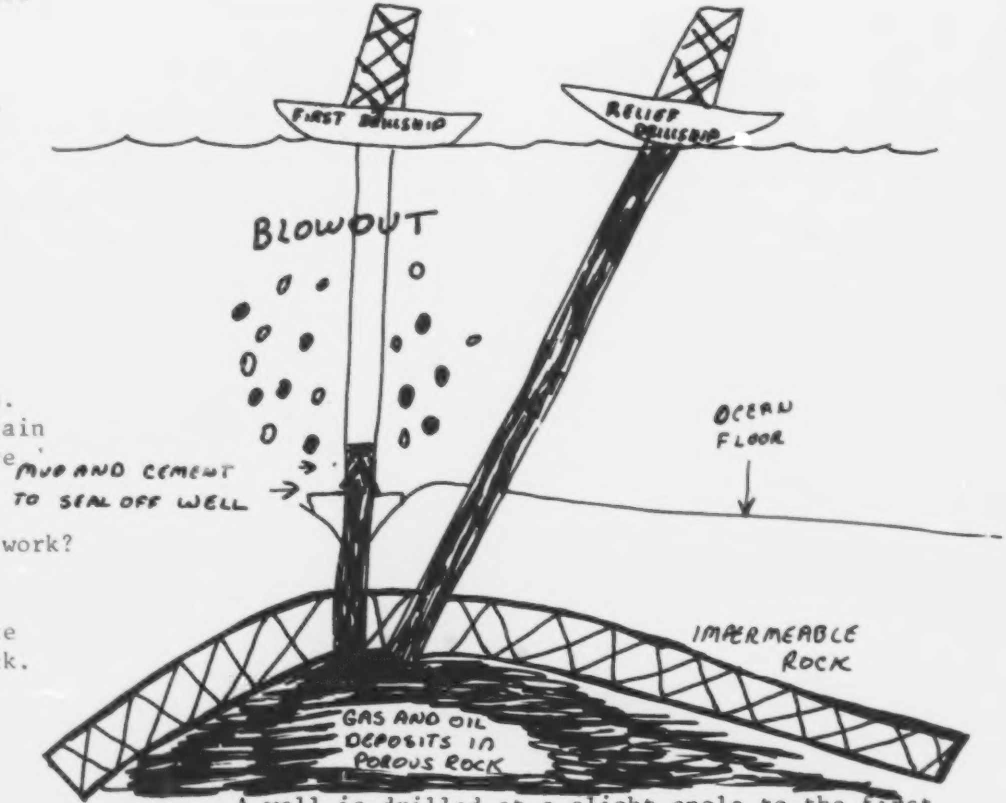
Cleanup requires efficient equipment. Does it work? Does the weather allow cleanup crews to work?

Ice floating around in the open water can create more problems as it passes through the oil slick.

HOW CAN A BLOWOUT BE STOPPED?

1. Capping the wellhead: This means replacing a damaged BOP stack. This is difficult and dangerous, especially if the wellhead is in deep water.

2. Drilling a relief well:


FIRST DRILLSHIP
RELIEF DRILLSHIP
BLOWOUT
OCEAN FLOOR
MUD AND CEMENT TO SEAL OFF WELL
IMPERMEABLE ROCK
GAS AND OIL DEPOSITS IN POROUS ROCK

A well is drilled at a slight angle to the first well to meet it just where it penetrates the top of the rocks that contain the gas and oil.

The mud and cement are pumped into the emergency well to seal off the blowout.

THE PROBLEM IS:

- It takes as long to drill the relief well as it took to drill the first well.

- It must be completed during the season when there is enough open water to allow drill-ships to navigate.

OIL AND SEA ICE

There are two main types of sea ice:

1) Landfast ice:

  - grows out from the shore.
  - forms and melts every year.
  - completely covers the part of the sea where it forms.

2. Multi-year ice:

  - does not completely melt each year.
  - keeps on moving with the currents.
  - pieces freeze together and break up again all winter.

CHARACTERISTICS OF SEA ICE

1. Sea ice grows downward.

2. It melts on top.

3. Sea ice is not smooth underneath. The older the ice is, the rougher its under-surface is.

4. Newly formed sea ice contains a lot of salt. The salt drains out during the winter. It leaves tiny channels in the ice. Therefore, sea ice that is one season old is porous. It has many tiny holes and channels through it.

IF THERE WAS A BLOWOUT UNDER LANDFAST ICE:

Gas and oil would collect in the pockets under the ice. (The pockets are formed by the rough under-surface.)

Gas bubbles would help spread the oil under the ice. The more gas there is, the further the oil will spread.

A lot of gas bubbling under the ice might build up and force the ice to bend and break. Then oil and gas might spread out on top of the ice.

As new ice grows downward, gas and oil from the blowout would be frozen into pockets in the ice.

The gas bubbles might keep the water moving so much that ice could not form. The lip of ice around the open hole might keep the slick from spreading. Much of the oil might collect right in the open area above the blowout.

As the salt drains out of the ice, the oil and gas will rise through the tiny holes left by the salt. By spring the ice will be like a sponge soaking up the oil. The oil and gas will rise to the surface of the ice.

The gas will evaporate. The oil will be left on top of the ice. When the snow melts on top of the ice, the oil will make the pools of melt-water black. It will float on top of these pools.

The oil will not begin to evaporate until it gets on top of the ice. Oil does not weather when it is trapped in ice.

The dark oil will make the ice melt very fast.

As the ice melts, the oil will be left on top of the sea. Then it will spread and drift with the winds and currents.

IF THERE WAS A BLOWOUT UNDER MOVING ICE:

As the ice floes (big pieces of ice) moved over the blowout, the bubbles would make them bob up and down. They would become coated with oil on all sides. Gas pressure might break some floes and spill oil onto the top of the ice.

The moving ice would carry oil away from the blowout. More ice would move over the blowout.

Oil would spread in leads and polynyas as they open and close. Oil from the ice would spread into the open water. Then it would be picked up by other moving ice and spread even further.

A relief well could not be drilled as long as ice was moving over the blowout site.

By summer, all the oil that was moved away from the blowout would be on the water except for the oil trapped in the multi-year ice.

Pack ice melts on top and grows from underneath. Thus the ice actually moves upward through a floe year by year. Multiyear ice renews itself about every ten years on the average.

Therefore, the longest that oil could remain trapped in the ice is about ten years. But all during those years, small amounts of oil would be coming to the top of the ice. The oil would be working its way up through the ice bit by bit.

Scientists think that most of the oil would probably reach the top of the ice within the first year. However, the ice would remain oil-stained.

In the spring marine birds return from the south. The first place they land is in the leads in the ice. If this open water is covered with oil, the birds will get covered with oil. Then they will die because they are no longer protected from the cold water.

Clean-up would be very difficult. It would be hard to track the oil, especially during the cold, dark season. It would be harder to find the oil that was being carried in the ice year after year.

OIL AND MULTI-YEAR ICE - LONG TERM EFFECTS

Scientists who have been studying the Beaufort Sea are worried about long-term effects of a big oil spill. They can only guess about the effects, but here is what they think could happen:

Multi-year ice (pack-ice) exists because not enough heat is absorbed in one year to melt all the ice in a floe. Each year some of the floe melts on top and some new ice is added underneath.

The pack-ice in the Beaufort Sea moves slowly around in a huge circle. This is called the Beaufort Gyre. It takes about ten years to go right around the circle.

There is about the same total amount of ice each year. This means that a huge amount of water is always in the form of ice.

However, if ice is blackened with oil, it will melt faster. The same amount of new ice would form each year, but more would melt each summer. There would be more water and less ice in the sea.

If huge amounts of oil were spilled and spread by pack ice, here is what could happen according to some scientists:

1. Sea levels along the shore would rise. This is because there would be more water in the sea.

2. More land would be covered by the sea.

3. The earth's climate might change.

   Right now, the earth's climate is the way it is because a certain amount of the sun's heat is absorbed, and a certain amount is bounced back into space.

   The total amount of heat absorbed by the earth stays the same from year to year.

   The white ice of the Arctic Ocean reflects a lot of heat back into space. You know that white surfaces reflect heat and that dark surfaces absorb heat.

   If huge areas of Arctic Ocean ice were blackened with oil, they would absorb more heat. They would reflect less heat back into space. Year by year they would soak up heat. The earth would get warmer. Heat doesn't stay in one place. It is moved around by wind.

   So a big change in the color of Arctic ice could change the climate of the earth.

IT IS IMPORTANT TO REMEMBER that no one really knows if the results discussed above are real possibilities. Some scientists have suggested that they could be possibilities if enough oil is spilled.

However, the technology to prevent serious spills is at such a high level that it is unlikely that a major spill will ever occur in the Arctic, and it is even less likely that a spill big enough to have the drastic results suggested above could occur.

CLEANING UP AN OIL SPILL

We wouldn't have to worry so much about oil spills if we knew how to clean them up.

Clean-up methods have not been very useful in areas of the world where there have already been big oil spills.

There has not yet been a big oil spill in the Arctic. However, we do know that the usual clean-up methods will not work very well there.

Scientists have been experimenting to try to find better methods for Arctic waters.

THE STEPS IN CLEANING UP AN OIL SPILL ARE:

1. Containing the oil. If the oil spreads too far and too thin, it is hard to clean up.

It is easiest to clean up the oil at the place where it is spilled.

2. Getting the oil out of the water or the ice.
3. Storage. You have to put the oil somewhere as you collect it.
4. Disposal. You have to put the oil in a place where it won't harm the environment.

There are many different conditions in Arctic waters:

1. open water and calm, clear weather.
2. open water and stormy weather.
3. open water with bits of floating ice.
4. open water with new ice forming.
5. solid, landfast ice.
6. moving pack ice.
7. water with lots of icebergs.

OTHER DIFFICULT CONDITIONS:

Clean-up would be made more difficult by:

- cold weather (men can't work, machines can't operate)
- poor visibility (lots of fog in October when the sea is freezing)
- freezing rains
- high winds
- blowing snow
- long hours of darkness.

CLEAN-UP METHODS USED IN OIL SPILLS AROUND THE WORLD

In open water: Some methods are useful if the weather is good. However, if there is lots of escaping natural gas, there is danger of an explosion.

Containment Booms: This is a curtain of wood, cloth, or metal hanging in the water from a floating collar.

It is towed across the front of the slick, or put around it to keep the oil from spreading.

The problems: Even small waves carry the oil over the boom.
: Currents can pull the oil under the boom.
: Moving ice can push the boom away.

Skimmer: This is a machine that sucks up or mechanically picks up the oil. It may be mounted on a barge. The oil is put into storage tanks.

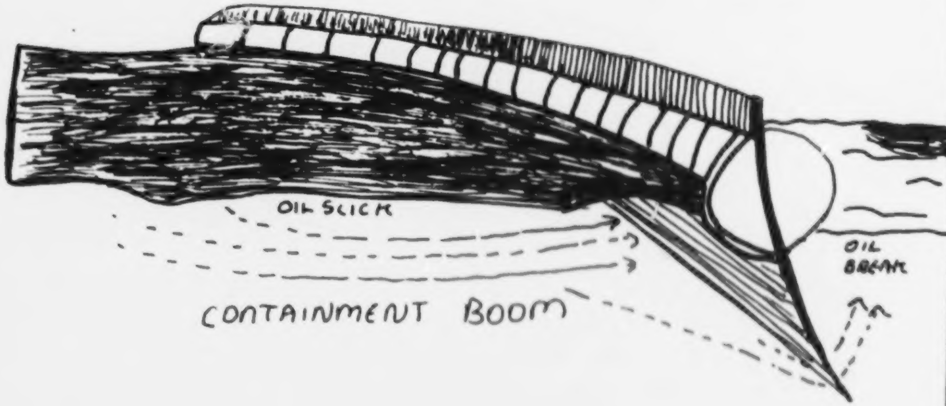
The problem: If there are waves or wind, it can't gather the oil.

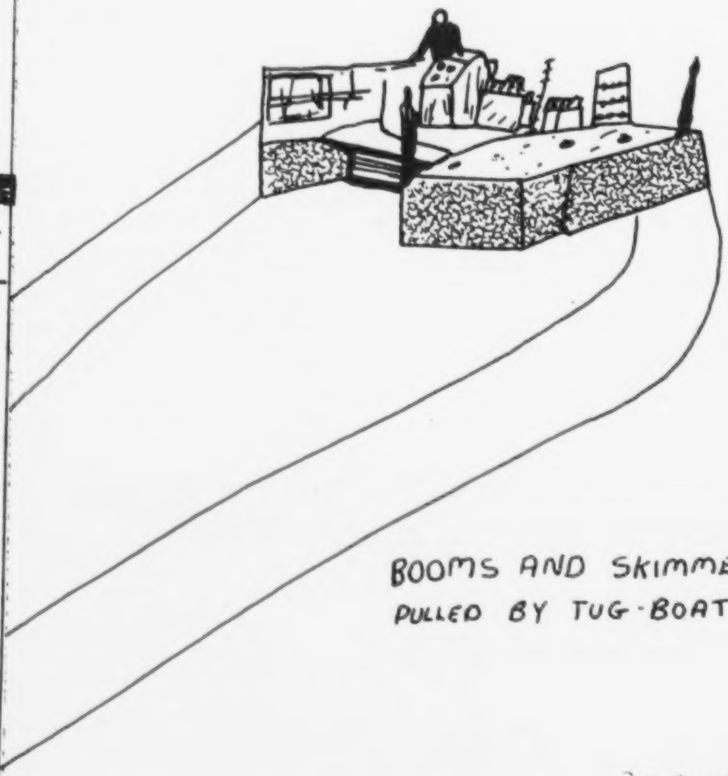
Chemicals: Certain chemicals will make the oil slick break up.

The problems: The chemicals are toxic. They are dangerous to plankton. Therefore they cannot be used in Arctic waters.

Microbes: These are tiny organisms that break oil down and make it harmless.

COUNTER MEASURES


OIL SLICK
OIL BREAK
CONTAINMENT BOOM



BOOMS AND SKIMMER
PULLED BY TUG-BOATS

The problem: They work too slowly in the cold, so they are of little use in the Arctic.

Soaking up the oil: Materials like plastic foam or straw are used to soak up oil.

The problem: It takes too much material to soak up a little oil.

Burning: Scientists think this is the best way to get rid of spilled oil.

The problems: If the oil has been open to the air very long, it won't burn.
: After it burns, there is still lots of sticky tar left. That must be cleaned up.

CLEAN-UP METHODS ON SOLID ICE

Oil could be collected under the ice
- in natural pockets.
- in holes blasted out of the ice.

Then the oil would be pumped into some kinds of tanks on the ice. However, no one knows what to do with the oil after that. How would it be disposed of? Perhaps it could be burned in special incinerators. It would have to be raised to a very high temperature to burn up.

Clean-up Crews: If oil was spilling out onto the top of the ice, men could work to clean it up by gathering it into buckets. However, this is very slow. Men could not work in bad weather.

Burning oil on ice: It might be possible to burn some of the oil as it rises to the top of the ice in spring.

However, it would have to be done as soon as the oil rose, otherwise it would not burn. It would have to be burned several times as the oil keeps rising bit by bit.

Burning could only be done while the ice was strong enough to support work crews.

The tarry part left behind would still have to be cleaned up.

Other Methods: Scientists may be able to build plastic underwater domes that could be put over a blowout site. However, no one has built one yet.

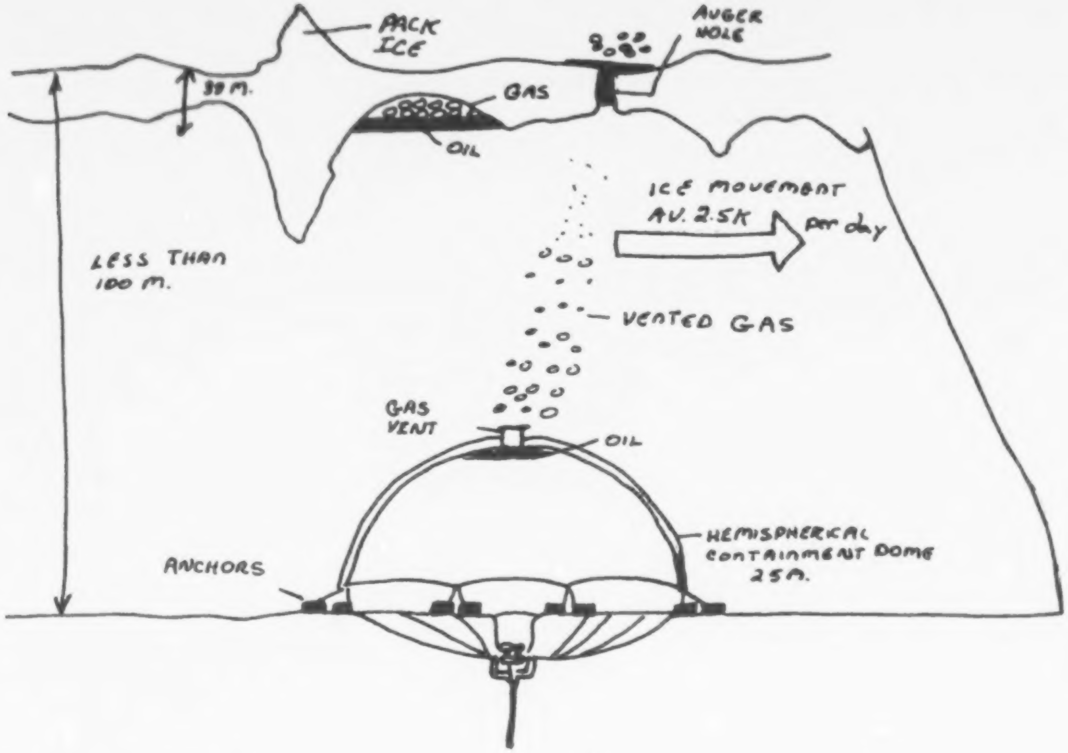
Cleaning up an oil spill in pack ice: This would be almost impossible because the oil would spread so far. The crews would have to find the oil before they could clean it up.

Darkness, cold, fog, blowing snow and ice would make it hard to track the oil.

Someday people may be able to track oil with small submarines. Scientists are trying to develop a way to track oil with radios.

How would the oil be cleaned up once it was found? No one is sure because of all the problems there would be:

- Working in moving pack ice would be dangerous.
- The oil probably wouldn't burn because it will be in small amounts and these will have been exposed to the air.
- Oil will be trapped in the ice.


PACK ICE
AUGER HOLE
30 M.
GAS
OIL
ICE MOVEMENT
AV. 2.5K per day
LESS THAN 100 M.
VENTED GAS
GAS VENT
OIL
HEMISPHERICAL CONTAINMENT DOME 25M.
ANCHORS

Underwater Dome

This is one method that has been suggested for containing oil from a blowout. However, no one has built one yet. Oil would be collected inside the dome and then would be pumped out into some kind of tank on top of the ice. Then it would be disposed of by some method such as burning.

(Reference: OilSpill Countermeasures, page 47)

PROBLEMS OF SHORELINE CLEAN-UP

Transportation: How do you get men and equipment in?

Weather: Arctic weather is often bad, cold, windy, damp, foggy or snowing or blowing snow. Shelter and warm clothing would have to be supplied to the workers.

Permafrost: If heavy machinery is driven over permafrost, the permafrost may be damaged.

Natural Breakdown: Bacteria and other natural forces work slowly in the Arctic.

Cliffs: In other places, cliffs have been sprayed with chemicals, then washed off with steam or hot water under pressure. But most cliffs on the Beaufort coast are made of frozen soil, not rock. They would melt.

Oil Spreading: Where the shoreline is low, oil could spread a long way inland. There are waves, storm surges, tides, and floods during high water. The tundra parts of the Mackenzie Delta are usually flooded in spring.

WHAT ARE THE CHANCES OF A BLOWOUT IN ARCTIC WATERS?

No one really knows. But scientists try to find out what the chances are by using probabilities.

These are special kinds of averages. Scientists collect all the information they can get on oil accidents all over the world. They consider how they happened and in what kinds of environments. They gather all the numbers they can get and then they put them into a computer to find out what the averages are. They use these numbers to work out the chances of a blowout.

Here is what they have learned:

- The risk of a blowout is very low when exploration wells are being drilled offshore.
- So far there have been no blowouts around the world in exploration wells. The blowouts have been in wells that were producing oil.
- The deeper the well the less chance of a blowout. So far, Arctic deposits have been farily deep.
- The chances of a blowout are greatest when a drillship is closing off at the end of a drilling season or when it is starting up again on an unfinished well at the beginning of a season.
- There is not much chance of a blowout when the drillship is away. Therefore there probably won't be a blowout during the winter where drillships are used.
- The risk of a blowout is about four times as great for a drillship as for an artificial island.

WHAT CAUSES BLOWOUTS?

One study of blowouts around the world found that the main cause of blowouts was human error. This can happen if:

- workers get sloppy about following safety rules.
- workers forget to check drilling mud pressure.
- workers install equipment the wrong way.

The second main cause of blowouts was equipment failures. That left only a small number caused in other ways.

THEREFORE:

Scientists agree that if workers are well trained and careful, and if equipment is good, there will be very little chance of a blowout.

KEY WORDS

petroleum
natural gas
petrochemical industry
oil reserves
OPEC
oil crisis
pipeline
tanker
liquified natural gas
hydrocarbon
porous rock
organic remains
geologist
impermeable
overburden
technology
artificial island
ice platform
drilling platform
drillship
hang off
marine riser
glory hole
drilling mud
blowout preventers (BOPs)
casing
drillstring
drill bit
crude oil
oilspill
blowout
wellhead
oil slick
relief well
sea ice
landfast ice
multi-year ice
leads
polynyas
Beaufort Gyre
containment boom
skimmer
microbes
incinerator
probabilities

WORKCARD

1. Explain how oil from a blowout would spread in or or under a) open water; b) landfast ice; c) moving pack ice.

2. Why would a blowout under moving pack ice be the hardest to deal with?

3. The law states that, in the fall, drilling must stop in time to allow the drilling of a relief well before freeze-up if it is necessary. Why was that law made?

4. What other laws do you think could be made to protect the environment during exploration?

5. What conditions make oilspill clean-up more difficult in the Arctic than in, say, the Gulf of Mexico?

6. The chances of a blowout are greater when drilling is done from a drillship than when it is done from an artificial island. Why?

7. As of the fall of 1982, no company has been given permission to drill for oil in Lancaster Sound. One of the reasons for withholding permission is that there are a lot of icebergs moving through the Sound. Why would icebergs be a problem? What precautions would a company have to take if they were drilling in iceberg-infested waters?

INPUT

We don't know what the effects of an oilspill would be.*

We don't know where the oil would go. Would it:

- be driven onto shorelines or out to sea?
- mix with the sea water?
- end up in pack ice and surface bit by bit for years?
- mix with silt and sink to the bottom?
- weather and disappear?
- be broken down by bacteria?
- end up on the coast of Greenland or the USSR?
- spread out quickly or slowlv?
- kill the plankton?
- have long-term effects?
- harm a big area or a small area?
- kill sea mammals?
- kill fish or make them dangerous to eat?
- stay on shorelines for years?
- kill shoreline vegetation?
- be driven inland?

We don't know what animals would do if there was an oil spill. Would they:

- avoid areas where oil was spilled?
- go into oil-stained areas?
- eat food poisoned with oil?
- avoid polluted food?
- move into an area where other animals have been wiped out by an oilspill?
- avoid having young in an area where oil was spilled?
- be unharmed?
- made ill?

We don't know how to save living things that have been covered or poisoned with oil.

We don't know why some areas have more sea life than others. We do know sea life is based on plankton, but we don't know why some areas produce so much more plankton than others.

We do know that a lot of things are very different from year to year in the arctic. This includes:

- freeze-up.
- break-up.
- daily and average temperatures.
- number and strength of storms.
- amount of open water.
- length of seasons.
- precipitation.
- ice movement.

We do know how to clean up an oil spill fairly well if:

- the waves are not very high.

*NOTE: We do have localized knowledge that can be applied in some places or situations. However, we lack much of the generalized knowledge that can be applied to all places and all situations.

- it isn't too cold to work.
- there isn't fog or blowing snow.
- the oil can be contained so it doesn't spread too far.
- there isn't too much ice.
- pack ice isn't moving over the blowout site.
- there is open water.

We don't know how to clean up oil if:

- it gets into pack ice.
- it has to be tracked over a winter.
- it spreads very far.
- it gets onto cliffs, mudflats or tundra.
- it is driven far onto shore by a storm surge.
- there is danger of an explosion because of the gas.

We don't know what to do with it after we collect it, if we do collect it.

HOWEVER:

Oil companies do know a lot about building good equipment. They have spent a lot of time and money searching for safe ways to drill for oil. They have built a lot of safety devices into their oil rigs. They check and test their equipment. They train their crews. They run safety drills.

Remember, most blowouts are caused by human error and by equipment failure.

The government departments who have the job of protecting the environment have decided that the equipment is good enough to prevent a blowout.

They have made laws to make sure that there is not much chance of pollutants getting into the environment. Every piece of equipment that is to be used for drilling must be tested by the oil company. Then it must be inspected by trained government inspectors.

All companies must have emergency plans. Their men must be trained so they know what to do if there is an emergency.

During the season when there is danger from ice, a government inspector must be on each drillship at all times. During the open water season, one inspector works four ships.

The inspectors can close the drilling season when the ice is getting dangerous.

The law says that drilling must stop so that there is still time to drill a relief well if there is a blowout.

Arctic oil exploration is only allowed in an area when the oil company can prove to the government that they have studied the area. They must prove that they will not damage the environment.

Scientists are doing a lot of research in the Arctic. They are trying to learn everything they can about oil in cold water. They are also trying to learn everything they can about the arctic environment and arctic wildlife.

The most important thing is that every effort is being made to protect the arctic environment. No major project is allowed to proceed until it is reasonably certain that the environment will not be unduly damaged.

RENEWABLE RESOURCES (approximately 15 hours)

OBJECTIVES

The study of this unit should provide the students with the background knowledge necessary to deal with the following situations:

1. The biology of animals important to the region will be introduced, with special reference to breeding, feeding and movement so that students will be able to identify the effect of various factors on population.

2. Students will be introduced to the techniques of gathering information about populations and will show how this information is used to make predictions and to produce quotas.

3. Laws affecting wildlife in the N.W.T. will be briefly discussed, as well as the powers of local Hunters and Trappers Associations, Federal and Territorial Government agencies, and public involvement in wildlife management.

4. The Renewable Resource Technology Program in Fort Smith will be highlighted, giving information about entrance requirements and course contents.

Teachers may wish to use resource personnel from the Department of Renewable Resources to aid in class discussions as well as some of the resources listed below. As in the unit on non-renewable resources, a typical outline and supplementary materials will be included.

Some alternate resources include:

1. Science Advisory Board of the N.W.T. publications:

    - aquatic resources of the N.W.T.
    - present status and future management of arctic marine mammals in Canada
    - management of some terrestrial mammals in the N.W.T. for sustained yields
    - fish, fur and game in the N.W.T.
    - fish, fur and game for the future

2. Endangered Habitat Wildlife in Danger.

    Available from:

    Canadian Wildlife Federation
    1673 Carling Avenue
    Ottawa, Ontario
    K2A 1CH

3. Arctic Animal Ecology

Available from:

Herman Remmert Springer-Verlay
New York.

4. Summary sheets on endangered wildlife in Canada.

Available from:

Government of the N.W.T.
Wildlife Service
P.O. Box 1320
Yellowknife, N.W.T.
X1A 2L9

List of species includes:

Threatened:

White pelican, piping plower

Endangered:

Greater prairie chicken, whooping crane, eskimo curlew, vancouver island marmot, sea otter, eastern cougar, wood bison.

5. Arctic Wildlife Teaching Notes:

Available through Resource Centres (Department of Education).

6. Wildlife Ordinance and Regulations:

Government of the N.W.T.

A package prepared by the Department of Renewable Resources has been included for your use. It outlines a suggested course of study for this unit. It is not intended that you teach every concept in this package. Students have been exposed to some of this material in grade nine. Choose the segments which you feel are particularly relevant. Choose the biology of animals important to your region and try to make use of the many audio-visual references which are outlined and available from your Regional Resource Centres.

Laws affecting wildlife in the N.W.T. should be discussed and even verified since they are subject to change from year to year.

SUGGESTED CONTENT/OUTLINE FOR RENEWABLE RESOURCES UNIT

Discussion and Activities

This unit, more than most others, will give you the opportunity to build upon the knowledge of your students and their parents. This brings with it a complication, in that if you are not a long-term resident of the community, your "book-learned" knowledge will not be as accurate and specific as their locally learned knowledge. You must also realize that the accuracy of 'scientific studies' has been disputed at various times. When teaching this unit avoid taking sides in contentious population politics.

The Environmental Studies Unit, Energy Food and Lifestyles, may be used to cover parts of this topic.

> Students should investigate at least two biomes, one of which will be their own. Emphasis should be placed on the influence of climate. As the plant life should have been investigated in L8.1, emphasis here should be on animals.

Populations and communities are perhaps easiest to introduce through a system that is relatively closed, such as a pond. This investigation is therefore best carried out just before continuous freezing temperatures reduce activity in and around ponds.

Work done on measurement and sampling in the pond will give students experience in estimating, collection of data, predicting etc., and will lead to a better understanding of the problems involved in the measurement of other populations, such as caribou, seals, wolves, etc., which follows in 2.4. Unit 2 of the Searching for Structure reference will give some ideas, although it is not specific to northern ponds. Your Wildlife Officer, if you have one, may be able to help with identification of plants and animals, and your students may know, or be able to find out, the local names for them. As with all experiments, you should be familiar with the area to be covered. Go to your pond the week before, do some collecting and identifying beforehand. You may wish to follow the work on pond life with some experiments on pollution as part of topic L9.2.

Students must understand that wildlife populations are dynamic. Once the general concepts have been assimilated, it is important that they be related to specific northern examples. As part of a class discussion or individual exercise, a different species from each biome may be chosen, and the various environmental and biological factors affecting health and survival enumerated. Life cycle diagrams may be useful.

It is important that students understand the relationship between research and actual management. Describe an imaginary population and form a "management committee" of students. The situation may be as simple or complex as the teacher desires. New factors may be introduced as a management strategy develops.

The application of laws is an important part of wildlife management. Teachers should be aware, however, that this is often a contentious issue with native people in the Northwest Territories, due to the broad hunting rights granted them in the N.W.T. Act.

Teachers are urged to ensure that their students are aware of the Renewable Resources Technology Program in Fort Smith.

SUGGESTED CONTENT/OUTLINE FOR RENEWABLE RESOURCES UNIT

CONTENTS

THE BIOSPHERE & NORTHERN BIOMES

Basic Terms & Concepts

Characteristics of Northern Biomes
- a) The Physical Environment
  - i) Solar Energy
  - ii) Precipitation
  - iii) Permafrost
  - iv) Snow Cover
  - v) Fire
- b) The Living Environment
  - i) Species Diversity & Numbers
  - ii) Simple Food Chains

Boreal Forest

Tundra

Animals of Northern Biomes
- a) Mammals
- b) Birds
- c) Amphibians & Reptiles
- d) Freshwater Fishes
- e) Insects

Adaptations to Northern Biomes
- a) Migration
- b) Body Insulation
- c) Body Shape
- d) Hibernation
- e) Shelter
- f) Camouflage
- g) Locomotion
- h) Food Storage & Fat Accumulation
- i) Reproduction

Bibliography

COMMUNITIES & POPULATIONS

NWT Biotic Communities
- a) MacKenzie Delta
- b) Slave River Lowlands
- c) Rankin Inlet Raptor Community
- d) Great Plain of the Koukdjuak

Sampling a Pond

Bibliography

WILDLIFE BIOLOGY

Habitat
- a) Food
- b) Water
- c) Space & Shelter
- d) Finding a Niche
- e) Habitat Limits
- f) Man-Made Changes in Habitat

Natality

Mortality
- a) Predation
- b) Hunting & Trapping
- c) Diseases & Parasities
- d) Other

Rare, Threatened & Endangered Species
Species Information
Bibliography

WILDLIFE MANAGEMENT

Research
- a) Taxonomy
- b) Anatomy and Physiology
- c) Habitat Studies
- d) Age and Sex Criteria
  - i) Sex
  - ii) Age
- e) Movement and Migration
- f) Numbers
  - i) Caribou Surveys
  - ii) Polar Bear Surveys
  - iii) Trend Data

- g) Harvest Data

Management
- a) Harvest Controls
- b) Habitat Protection
- c) Predator Control
- d) Wildlife Transplants

Bibliography

LAWS AND JURISDICTIONS

Migratory Birds......................................

Fish & Marine Mammals................................

Terrestrial Mammals..................................
    a) Public Involvement in Wildlife Management......
    b) Hunters and Trappers Associations..............
    c) Wildlife Guardians.............................

CAREERS..

Basic Terms & Concepts

Ecology is the science which deals with interactions between organisms and their environment.

The biosphere is the relatively thin shell around the earth, extending only a few kilometres above and below sea level, which includes all parts of the water, land and air inhabited by living things.

Ecologists have attempted to categorize areas within the biosphere in a number of different ways, based variously on similarities of flora, fauna and environment. Two terms commonly employed are "biome" and "ecosystem".

A biome is a broad region within the biosphere characterized by distinctive life forms typical of a geographic area with one type of climate. Two biomes in the NWT are boreal forest and tundra.

An ecosystem is a unit which, unlike a biome, comprises both the living organisms and the non-living environment interacting to produce an exchange of materials between them. This word can be used to describe either large or small units.

Each ecosystem has four basic components: the physical or nonliving environment, the producers (green plants), the consumers (animals), and the decomposers (macro-organisms such as worms, and micro-organisms such as bacteria and fungi).

a) The physical environment consists mainly of soil, air, light, and water. Associated factors are temperature, wind, fire and topography.

b) Green plants interact with the environment to produce and store energy (food). This is done through photosynthesis.

c) Consumer animals are placed in three categories: herbivores, carnivores and omnivores. Herbivores eat plants, carnivores eat other animals, and omnivores eat both plants and animals. Herbivores play an essential role, as only they are capable of converting plant tissue to animal tissue.

d) Decomposers make up the final feeding group. They break down organic material (dead plant and animal matter, excreta) so that nutrients are returned to the ecosystem, or the biome, in a form which can be utilized by plants.

This transfer of food or energy from its primary organic source (plants) through a series of organisms is called a _food chain_. Since no organism lives wholly on another, resources are shared, especially at the beginning of a chain; thus food chains become interlinked to form a _food web_.

Within each ecosystem or biome there exist many _communities_ of organisms. A community is a local association of plants and animals linked by the same food chain or web. Communities often overlap.

The total number of each species of plant or animal within a community is termed a _population_. Each population performs a specific function within a community, called a _niche_.

Characteristics of Northern Biomes

a) The Physical Environment

i) Solar Energy

Northern biomes receive less solar energy than temperate or tropical biomes. In the winter the total energy received is very low because of long periods with little or no daylight. In the summer, days are longer in the north than elsewhere, but the light is less intense because of the angle at which the sun's rays pass through the atmosphere, so the total amount of solar energy received in the north in June and July is almost the same as that received in temperate latitudes. Thus the north has extreme seasonal variation in radiation levels as well as a low net energy input.

Food production is limited due to low temperatures and the short growing season. Low soil temperatures slow chemical weathering and decomposition so that the availability of nutrients is limited. Since total plant production is low, the total production of animal matter is also low.

This is logical if you remember that biomass (the total mass of living matter) is a function of energy. Energy is transferred at each level of the food chain, and with each transfer a certain amount of energy is lost (in body heat, excreta, etc.). Therefore, if energy input is low, total biomass will also be low.

ii) Precipitation

"In general, precipitation decreases northward. Large portions of the boreal regions, especially the continental tundra and the High Arctic, are 'deserts' in terms of actual precipitation." (Pruitt 1978)

iii) Permafrost

Permafrost is permanently frozen ground. It forms wherever the ground loses more heat than it gains over an extended period of time. "The southern limit of permafrost coincides roughly with the -1°C mean annual air isotherm" (Pruitt 1978). Most tundra is underlain by continuous permafrost, while most of the remainder of the NWT is underlain by discountinuous permafrost. Despite low precipitation, there are large expanses of wet and boggy areas because permafrost prevents water from draining away. Permafrost also prevents the deep penetration of roots, often resulting in unstable vegetation, especially trees.

For more detailed information on permafrost, refer to E8-2.

iv) Snow Cover

Snow covers the ground for a large portion of the year. It acts as an insulator which protects plants and burrowing animals from colder temperatures in the open air. It also hinders animals, such as moose and caribou, in their movements and in their search for food.

v) Fire

Fire plays a minor role on the tundra, but in the boreal forest it is believed by many experts to be a significant ecological factor. Most fires occur naturally, mainly through lightning strikes. Fire has a beneficial effect by returning nutrients to the soil -- nutrients which would otherwise remain locked up within mature or over-mature forest stands. Burned areas therefore produce new vegetation growth preferred by such species as moose, beaver, and hares. The effect of fire over a long period of time produces a mosaic-like effect within the forest -- a combination of new growth suitable for some species, and older growth suitable for others (e.g. squirrels, marten). Many authorities believe that the boreal forest is a "fire-dependent ecosystem whose components have all evolved in the presence of wildfire, perhaps even in response to wildfire". (Allison 1979).

For further information, teachers may refer to the following publication, available from the N.W.T. Wildlife Service:

> Allison, Lorraine. 1979. Fire Management: The Relationship of Fire and Wildlife to Fire Management in the Northwest Territories. NWT Wildlife Service Contract Report No. 1. 45pp.

b) The Living Environment

i) Species Diversity and Numbers

The farther north one goes, the number of species inhabiting an area decreases. This is true for plants and animals. (In the NWT there are virtually no amphibians or reptiles.) In addition, population densities are low in comparison to more southern areas.

ii) Simple Food Chains

With fewer species being present, food chains and webs are necessarily less complex. They are also more fragile. This means that numerical fluctuations of one species, especially one that occupies a niche low on the food chain, has a great effect on other species. This is clearly seen in the case of hares and lemmings, which experience cyclical population fluctuations. When a population of snowshoe hares crashes, lynx populations crash soon after. The same is true of lemmings and arctic foxes.

Boreal Forest

The boreal forest is one of eight recognized forest regions of Canada, and covers a substantial portion of the nation. It is the only forest region found in the NWT, and has been divided into seven forest sections: Hay River, Upper MacKenzie, Lower MacKenzie, Upper Liard, Northwestern Transition, Forest-Tundra, and Alpine Forest-Tundra. (Rowe 1972)

On a more general basis, the boreal forest can be divided into two main areas --- open boreal forest and closed boreal forest -- since trees become stunted and more widely spaced as the treeline is approached. Most of the forest in the NWT is of the open variety; the smaller closed portion borders half of the southern length of the MacKenzie River and extends south of Great Slave Lake to the Alberta border.

The dominant trees are conifers, mainly white and black spruce. Other conifers include jackpine and tamarack. In the open boreal forest, black spruce is the most abundant tree. Tamarack is common in boggy areas, while well-drained areas produce white spruce. Jackpine is common only in the southern part of the boreal forest in sandy and rocky areas.

Deciduous trees found in the boreal forest include birch, poplar, willow and alder. They are found on selected sites throughout the boreal forest.

The forest floor is composed of mosses and lichens, and plants such as blueberry, crowberry, raspberry, and cranberry. The production of berries is important to the lives of many animals in the boreal forest.

The boreal forest is checkered with areas of sphagnum bog or muskeg.

Tundra

The vegetation associations of the tundra are structurally simple, dominated by grasses, sedges, mosses and lichens. Dwarf forms of willow and birch are also found occasionally. Most of the vegetation is perennial, and vegetative reproduction is common, as the short growing season may hinder flower and seed development. Plants must be able to withstand constant soil disturbance, buffetting by the wind and abrasion from wind-carried particles.

> Because of the cold climate, short summers, low soil temperatures, sparse vegetation, and slow decay of organic matter, arctic soils are poor and deficient in nitrates, phosphates, and other salts. Where these nutrients are added to the soil, as around bird cliffs, animal burrows, goose nesting grounds, and present and past areas of human habitation, the vegetation is lush and green... (Smith 1974)

Typical of the tundra biome are unusual surface features caused by frost heaving -- pingos, palsas, polygons and frost boils. On slopes, the annual freezing and thawing of the active layer can result in a gradual downward creep of soil.

The fragility of the tundra ecosystem makes it especially vulnerable to human disturbance.

> Because the permafrost has a controlling influence over the arctic ecosystem, any disturbance to soil cover can affect the permafrost, and that in turn affects the tundra ecosystem. The activities of man tend to reduce the effectiveness of vegetation as an insulation for permafrost, leading to its degradation and thawing. Over wide areas of the arctic, permafrost is in such a delicate balance that even minor disturbances can have disastrous consequences. Removal of mosses and lichens can increase the depth of thaw 20 to 50 percent. Footpaths used for only one season may persist unchanged for decades. Frequent vehicular traffic slices up the tundra. (Smith 1974)

Despite the harsh conditions on the tundra, summer brings a burst of animal activity. Caribou migrate to calving grounds, and myriads of birds arrive from the south to nest and rear young. Waterfowl and shorebirds especially are attracted to the arctic's wealth of lakes, ponds, marshes and seashores.

Animals of Northern Biomes

a) Mammals

A comparison of the mammals occurring in the tundra and the boreal forest illustrates the northward reduction of species diversity. (Common names are taken from Banfield's The Mammals of Canada.)

	Boreal Forest	Tundra
Shrews	masked, dusky, water, arctic, pygmy	masked, arctic
Bats	little brown, hoary	-
Rabbits & their allies	pika, arctic hare, snowshoe hare	arctic hare
Squirrels & their allies	red squirrel, northern flying squirrel, arctic ground squirrel, least chipmunk, woodchuck, hoary marmot	arctic ground squirrel
Mice & their allies	deer mouse, northern red-backed vole, Gapper's red-backed vole, heather vole, singing vole, meadow vole, tundra vole, long-tailed vole, chestnut-cheeked vole, brown lemming, northern bog lemming, collared lemming, muskrat	northern red-backed vole, meadow vole, tundra vole, brown lemming, collared lemming
Other rodents	meadow jumping mouse, beaver, porcupine	-
Dog-like mammals	coyote, wolf, arctic fox, red fox	wolf, arctic fox, red fox
Cat-like mammals	lynx	lynx
Bears	grizzly, black bear	grizzly, polar bear
Weasels & their allies	marten, mink, fisher, ermine, least weasel,	ermine, wolverine

	wolverine, striped skunk, river otter	
Deer-like mammals	caribou, moose, white-tail deer	caribou, moose
Cattle-like mammals	bison, Dall's sheep, mountain goat	muskox

Note that not all species listed above occur in all parts of their respective biomes.

Note also that rabbits do not occur in the NWT. "Rabbits differ from hares in that their young are born naked, blind, and helpless in underground burrows, while young hares are born eyes open and fully haired in a surface nest or form. Young hares are precocious and are able to run soon after birth." (Banfield 1974)

b) Birds

Most birds found in the NWT are summer residents, some coming from as far away as South America and Europe for the nesting season. The birds that stay for the winter are grouse and ptarmigan, various owls and woodpeckers, the raven, and a few small birds such as the gray jay, boreal chickadee, pine grosbeak, hoary redpoll, and whitewinged crossbill.

c) Amphibians & Reptiles

Warm-blooded animals have been able to adapt to northern climatic conditions, but in general reptiles and amphibians have not. There are no reptiles at or beyond the treeline, and the wood frog is the only amphibian found near the treeline because it can produce eggs in water temperatures that are close to freezing.

Warm-blooded animals generate their own heat from the food they eat, but reptiles and amphibians have body temperatures that reflect their surroundings. The few amphibians and reptiles that live in the boreal forest hibernate for up to 8 months. "It is the lack of summer warmth, not the severe cold of winter, that is critical -- as long as suitable places for hibernation are available" (Hodge 1976).

> The wood frog is found throughout the taiga and adjacent tundra of the Yukon and Northwest Territories. The only other amphibian or reptile with an extensive distribution north of 60 latitude is the chorus frog, which is found in the Northwest Territories from Great Bear Lake south to the provincial borders. The mixed wood forest

(boreal forest, aspen groves, grassland) extends northward to the area around Fort Smith which straddles the Northwest Territories/Alberta border. This prairie influence brings the leopard frog, Canadian toad and garter snake into the territory.

(Hodge 1976)

d) Freshwater Fishes

As with mammals, there are less species of freshwater fish found in the waters of the boreal forest than in those of the tundra. (Common names are taken from Scott & Crossman's Freshwater Fishes of Canada.)

	Boreal Forest	Tundra
arctic lamprey	X	
chum salmon	X	
arctic char		X
Dolly Varden	X	
lake trout	X	X
cisco (lake herring)	X	X
arctic cisco	X	X
least cisco	X	X
lake whitefish	X	X
broad whitefish	X	X
round whitefish	X	X
inconnu	X	
arctic grayling	X	X
pond smelt	X	
rainbow smelt		X
goldeye	X	
northern pike	X	X
northern redbelly dace	X	
finescale dace	X	
lake chub	X	X
emerald shiner	X	
spottail shiner	X	
fathead minnow	X	
flathead chub	X	
longnose dace	X	
pearl dace	X	
longnose sucker	X	X
white sucker	X	
burbot	X	X
brook stickleback	X	
3-spine stickleback		X
9-spine stickleback	X	X
trout-perch	X	

yellow perch	X	
walleye	X	
slimy sculpin	X	X
spoonhead sculpin	X	X
deepwater sculpin	X	

Note that not all species listed above occur in all parts of their respective biomes. Some in fact have very limited distribution.

e) Insects

Insects are a very obvious part of northern biomes in summer. There are insects everywhere in the north, even in the most barren rock and gravel plains of the tundra.

In northern biomes, Dipterids (which include blackflies, deerflies, horseflies and mosquitoes) form a greater proportion of the total number of insect species than in temperate zones, where beetle species are generally more numerous. (Pruitt 1978)

Dipterids generally require an aquatic environment for the survival of their larvae. The muskegs, bogs, ponds, lakes and rivers of northern biomes supply excellent breeding habitat for these insects. The hordes these areas produce, plus the fact that the female Dipterids mentioned above feed on the blood of both humans and animals, have made these insects notorious.

Some, such as deerflies, are important disease vectors. Deerflies are known to transmit tularemia and anthrax.

Other insects include mites, lice, ticks and fleas, which live on various animals. Blowflies breed on animal carcasses. Warble flies deposit their eggs on the backs of caribou in summer and their larvae live all winter beneath the skin, then burrow out in the spring and fall on the ground where they pupate.

Other invertebrates, such as roundworms and tapeworms, are common parasites found in many northern animals.

The beneficial aspects of insects are less well-known. They assist in the pollination of plants. They also play an important role in the energy cycle of northern biomes. Both adult and aquatic larval forms are fed upon by fish, while adult forms are eaten by birds. Insects that get their food from animal excreta and from dead animals and plants transform matter that would otherwise be lost from the food chain.

Adaptations to Northern Biomes

All northern animals have some physical and/or behavioural adaptations that help them to survive in the north.

a) Migration

"The migratory habit enables many species to exploit new food resources at different times of the year or seek more favourable environments" (Smith 1974). Animals which migrate northward in the spring are taking advantage of relatively empty, unexploited areas -- especially on the barrens. This enables them to bring forth young in an area where food is abundant and competition low.

Caribou are continually on the move because large tracts are necessary to support their numbers. The migratory habit is most clearly established in the caribou subspecies Rangifer tarandus groenlandicus (barren-ground caribou), which characteristically migrates to specific calving areas in the spring. This subspecies has been divided into four major herds or populations (Bluenose, Bathurst, Beverly, and Kaminuriak), all of which winter below the treeline and summer on the barrens. Other herds of barren-ground caribou remain on the barrens year round -- as in northern Keewatin and on Baffin Island -- but these too undertake seasonal migrations of varying extent. The migratory habit is less firmly fixed in the two other subspecies found in the north: woodland caribou and Peary caribou.

Most species of birds found in the NWT are migratory. Individual birds often return year after year to the same location. As a result, bird sanctuaries have been established to protect important nesting areas. Perhaps the most conspicuous of migratory birds are waterfowl. They utilize a number of specific migratory paths, called "flyways". With a few notable exceptions (eiders and oldsquaws), ducks tend to utilize the boreal forest more extensively than the tundra, while the reverse is true for geese.

Fish migrations are mostly for the purpose of spawning and feeding. The migrations of arctic char are probably the most well known in the north. They winter in lakes, migrate to the ocean in the spring, then return upriver in the fall to spawn. They, like most species of salmon, are unusual in that they can survive in both fresh and salt water. Not all char, however, are migratory. Some populations remain year round in lakes and rivers; they are generally smaller than sea-run char.

Lake trout and lake whitefish also spawn in the fall, when they move to lake shallows. Two other common northern species, arctic grayling and northern pike, spawn in the spring. Arctic grayling move from lake and river systems to tributary streams for spawning, while northern pike move to heavily vegetated floodplains of rivers, marshes, and bays of larger lakes.

b) Body Insulation

Animals living in cold climates must conserve their body heat to maintain life. Most mammals have a double layer of fur -- an outer layer of long guard hairs overlaps a dense inner layer of short wool.

> Hair, being non-living material, is subject to considerable wear and bleaching of pigments. During periodic molts, usually once or twice a year, old hairs are lost and new one replace them. This often occurs in a regular pattern of replacement. In many north-temperate species the molts are in spring and fall, and the summer pelage is generally shorter and has less insulating ability than the winter pelage. (Vaughan 1972)

Waterfowl, like mammals, have a dense undercoat (down), and undergo annual moults. The use of fur and down-filled garments by humans attests to their insulating ability. Down can be collected from the nests of waterfowl, particularly geese and eider ducks, which pluck down from their breasts to line their nests. The pelts from fur-bearing animals are generally most prized when taken in early winter when the hair is long and dense, and has been subjected to little wear.

Certain animals such as ermine and arctic fox change colour in summer when cells within each hair are filled with pigment. In winter when the hairs lose colour (turn white), the cells are filled with air rather than pigment, and the air adds to the insulation value of the coat.

The hairs of caribou are not only full of tiny air cells, but are also thicker at the tip than at the base, so that extra air is trapped within the coat, thus increasing the insulation value of the coat without increasing its weight.

Northern animals also tend to have more complete fur or feather covering on their extremities than southern animals. Ptarmigan have entirely feathered legs and toes. The feet of wolves and polar bear are completely fur-covered except for the fleshy footpads.

At the opposite extreme birds such as sea gulls, which stand for long periods on ice and snow, have developed special mechanisms which reduce the amount of heat flowing to their legs and feet, thus limiting heat loss.

Many northern animals can fluff up their fur or feathers to trap extra air within the coat (e.g. fox, wolf, husky dog, raven, ptarmigan).

Most arctic animals also have a layer of fat beneath their skin that adds insulation and also stores energy for times of scarcity. Marine mammals have a much thicker layer of fat than land mammals, since water conducts heat away more quickly than air.

c) Body Shape

Size is related to heat loss: the larger the animal, the slower the rate of heat loss through the skin relative to heat production. Thus larger mammals can stay outside and hunt for food when smaller animals must take shelter in burrows or tunnels.

In addition, northern mammals have more compact body shapes, and shorter and blunter extremities. Small and stubby ears, noses and tails, and shorter legs, mean less body surface for heat loss.

Mammals like the husky dog can change their body shape by curling up so that less body surface is exposed to the elements.

d) Hibernation

True hibernation means that a mammal's body temperature drops step-by-step (not suddenly) to a temperature close to that of the inside of the cave or burrow. If the burrow temperature gets close to freezing during the winter, the mammal's metabolism speeds up just enough to keep it out of the danger zone. During hibernation no growth occurs and little energy is used.

In the tundra biome only the arctic ground squirrel truly hibernates. Its body temperature drops close to freezing and its heart beat and breathing rate slow. In the boreal forest the chipmunk, woodchuck, skunk and meadow jumping mouse, as well as the arctic ground squirrel, hibernate. However, if temperatures stay very low for too long in the season, these animals will freeze to death in their burrows.

Many animals stay in a state of dormancy for part or most of the winter. Small animals such as mice, lemmings and shrews stay dormant part of the time and run around in tunnels under the snow or ground the rest of the time.

The grizzly and the black bear are dormant during the winter, but this is not true hibernation because these bears can awake fairly readily if disturbed. The female polar bear dens up to have cubs, while the male dens up and sleeps when food is scarce, but they do not hibernate.

e) Shelter

Many northern animals make shelters that help them conserve heat in the coldest weather, Shrews, mice, voles and lemmings make burrows and tunnels under the snow. The red squirrel makes a tree nest of grass and leaves and stays in it during the coldest weather. Polar bears dig dens in snowbanks. Grouse take shelter in drifts under roots and bushes. Ptarmigan nest [illegible] into a depression in the snow. Beaver construct lodges and remain active throughout the winter. Muskrat build houses of mud and vegetation, or live in bank dens; in winter they construct "push-ups," piles of vegetation covering a hole in the ice, within which they feed.

f) Camouflage

Camouflaging is a survival tactic employed by animals the world over. In the north the most obvious examples are the snowshoe hare, ptarmigan and arctic fox, which change colour seasonally so that they blend in with snow in winter, and with ground cover in summer. Polar bears and snowy owls remain white the year round.

g) Locomotion

Many northern mammals have special adaptations that enable them to travel or forage for food when there is snow cover. The snowshoe hare and the lynx have big feet that distribute their body weight on the snow much like snowshoes do. Caribou have large hooves that provide support when the animals traverse muskeg, and prevent skidding when they walk on icy surfaces.

h) Food Storage & Fat Accumulation

Many over-wintering animals hoard food for winter. The arctic fox caches lemmings, eggs, and fledglings; the beaver collects branches from felled trees and submerges them in ponds for future use; the red squirrel stores seeds, and the gray jay hides bits of food in holes and cracks in trees.

Other animals accumulate fat on their bodies during summer and fall as a way of storing energy. During winter when food is scarce these fat reserves are used up. Birds accumulate fat just prior to the fall migration so that they will have sufficient energy reserves for their long flight. Students who eat wild meat will be aware that animals such as moose and caribou have much more fat on their bodies in October than in May.

i) Reproduction

Most larger mammals give birth in late winter or spring, which coincides with the beginning of the growing season, so that their young can take maximum advantage of the summer food supply to grow and store up energy for the winter.

The time of mating varies according to the length of gestation, so that late winter or spring parturition is achieved.

An important exception to this regime occurs among bears. They generally give birth in mid-winter, but the female and cubs do not leave the den until late winter.

The reproductive strategy of bearing or first exposing young in late winter or spring has resulted in an interesting characteristic in bears and northern mustelids (weasels and their allies), called delayed implantation. Following mating, implantation of the blastocyst does not occur for months. Once the blastocyst is implanted, foetal development occurs in a normal manner. Ermine, for example, mate in early summer, but the blastocyst is not implanted until the following March. Birth occurs a month later.

If food is scarce some species (e.g. arctic fox) will not breed at all, while others (e.g. wolves) produce less young.

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COMMUNITIES & POPULATIONS

A community is an assemblage of plant and animal species linked together by a food chain or web. As with the term ecosystem, its scope is flexible, ranging from the inhabitants of a pond or fallen log, to the sum of organisms inhabiting a complete biome. Although some communities have sharply defined boundaries, most blend together gradually.

NWT Biotic Communities

The following are examples of some larger plant and animal communities in the NWT.

a) MacKenzie Delta

The MacKenzie Delta is a "a maze of islands, channels, lakes and swamps. It is forested, except for tundra areas along the coast.... It has a warmer summer and longer season of open water than the areas just east and west of it. The Delta itself may be likened to a huge, wet sponge. It is one of the most productive areas for wildlife in the Canadian Arctic, supporting innumerable muskrats and substantial populations of other furbearers, such as beaver, mink and marten, as well as fox, bear, moose and a variety of small mammals. The channels and lakes of the Delta abound with fish. In summer, many thousands of waterfowl and other birds pass through the Delta or nest there." (Berger 1977)

b) Slave River Lowlands

Northwest of Wood Buffalo National Park, and bordering the Slave River from Ft. Smith to Great Slave Lake, is an area of rich flat lowlands. It is characterized by large patches of open prairie abundant in sedges and grasses. The area is utilized by moose, sandhill crane, and migrating waterfowl. The population of most interest, however, is the bison. This population contained about 1700 individuals in 1971, but by 1981 had dropped to about 300. The reduction was due to a combination of factors, including wolf predation, hunting,adverse winter weather, and disease. In addition to tuberculosis and brucellosis, bison have suffered from periodic outbreaks of anthrax, a disease which can remain dormant in the soil for extremely long periods of time until environmental factors conspire to bring it to potency.

c) Rankin Inlet Raptor Community

A small raptor community exists in the vicinity of Rankin Inlet. Two species of raptors nest in this area: peregrine falcon and rough-legged hawk. Both species require similar terrain for nesting -- rocky outcrops of at least 30-40 m in height with steep rock faces. In 1981 there were about 15 pairs of nesting peregrines. Peregrines prey mainly upon smaller birds, such as passerines (perching birds), shorebirds and sea birds (e.g. guillemots). Rough-legged hawks, though nesting in the same area, prey mainly on small mammals, such as lemmings and arctic ground squirrels. Ordinarily 20-30 pairs of nesting rough-legged hawks occupy the area, but in 1981 the lemming population was at a low point in its cycle, and as a result only one pair of rough-legged hawks was observed nesting.

d) Great Plain of the Koukdjuak

This large area of tundra (nearly 19 000 km^2) is located on the west side of Baffin Island between Nettilling Lake and Foxe Basin. It is a flat water-logged plain marked by many small streams and ponds. It supports the largest goose colony in the world; in summer about a million geese (mostly snow geese) may be found in this crucial nesting area (Nettleship and Smith 1975). It also lies roughly between calving grounds in the north, and winter range on Foxe Peninsula to the south, for South Baffin migratory caribou. A substantial portion of this herd crosses the plain in late winter in order to reach the calving grounds, and returns after calving to summer in the area. In the winter this vast area is almost completely devoid of animal life.

Sampling a Pond

Students may investigate the nature of communities by sampling a pond. Make a dip net by attaching a kitchen sieve to a broom handle with wire. Take large jars with you and fill them with water at the pond. (Don't use tap water; it has chlorine in it). Sweep the net rapidly through the water and empty it into your jar of water. Collect plants, rocks and mud from the bottom as well.

If you have field guides available, you may wish to identify some of your samples. It is, however, possible to examine the species and their relationships without identifying them.

Students can examine the species collected by pouring some of the material collected into a white-bottomed dish. A glass pie plate with a piece of white paper under it will do nicely. A hand lens will be needed. Students can make drawings of the creatures, and observe them to discover the niche that each one occupies in the food chain.

List the different species and count the number of each species in the sample collected. Pour the water, animals and bottom material into an aquarium tank and make daily observations for a week. Have students describe movement, predator-prey relationship, etc. Keep a record of observations.

After a week, count the animals again. Which groups have increased, decreased, disappeared, or remained stable? Have students make a food web drawing to show the relationships.

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Habitat

Each animal species has special requirements for food, water and shelter. Unless an area has all the needed elements, the species will not prosper. Depending on the size and mobility of an animal, its range will be great or small. Large ungulates such as moose and caribou require a greater volume of food than lemmings and voles, and therefore range over larger areas.

a) Food

This is the most obvious habitat requirement for animals. Different kinds of food are required in suitable quality and quantity by different species.

Herbivores play an important role in the ecosystem because only they can utilize plants for food (convert plant tissue to animal tissue). Many have developed unique physiological features in order to do this. Caribou have a stomach with four compartments in order to digest plant material. In addition, they are cud-chewers; a cud of vegetation is returned to the mouth from the stomach and rechewed. Hares have a digestive process called reingestion or refection. "Two types of material are eliminated from the alimentary tract. The first consists of normal brown faecal pellets, and the second of soft green pellets, composed of only slighty predigested plant food, which are passed mainly during the daytime rest period. These are sorted out by the animal and reingested" (Banfield 1974).

Herbivores must obtain all of their nutritional requirements from plants. In addition to carbohydrates, proteins and vitamins, they also require a number of different chemical elements such as calcium and phosphorous. Animals failing to obtain all of these nutritional requirements will experience metabolic deficiencies. Often it is the quality of the food rather than the lack of quantity which adversely affects herbivores. Winter in particular can be a difficult time, for not only may food be scarce or difficult to locate under snow, but the nutritional quality of plants is lowest in winter.

"Carnivores have found the simplest answer to nutritional needs and a balanced diet. By eating other animals they obtain the various elements that the others had obtained in the course of their lifetimes; and these are usually adequate to support the carnivore" (Dasmann 1964).

Consequently carnivores tend to suffer more from a lack of food than from poor food quality.

b) Water

All animals require water, but not all animals obtain it by drinking. Since free water is not available to animals during winter in the north, they must obtain it from the food they eat and from snow.

Other animals require water in the form of ponds, lakes and marshes for cover or shelter as well as food supply. Waterfowl, for example, feed on aquatic vegetation and invertebrates. They cannot live where free water does not exist.

c) Space & Shelter

Many animals require a specific type of habitat for the building of nests, dens or burrow. Others require specific habitat features that they can use to escape from predators, for courtship displays, for mating and the rearing of young.

Some animals exhibit antagonism towards others of the same species. These animals therefore also require a minimum amount of space, called a territory, for maintenance of health. "Territorial spacing can serve as a mechanism to prevent the overcrowding of a habitat, and thus guarantee to each individual or territorial group a space within which its necessities are available and are maintained for its exclusive use" (Dasmann 1964).

Many species of birds exhibit territorial behaviour. Among mammals in the north, wolves commonly (but not always) maintain territories.

d) Finding a Niche

Each animal species must find the habitat for which it is adapted, and which is unoccupied. An area cannot support two species with exactly the same needs. Animals that might at first appear to have the same habitat requirements must actually differ in some way if they are in the same area. Of the animals in any given area, some eat plants, others eat animals or scavenge. Some feed at night, some in the daytime.

The Rankin Inlet raptor community (discussed under Communities & Populations) offers a good example. Though living in the same area and requiring similar nesting sites, the peregrine falcon and the rough-legged hawk do not compete for food since they prey on different types of animals. When the population of lemmings reached a low point in 1981, the rough-legged hawk was affected but not the peregrine falcon.

e) Habitat Limits

There is a maximum number of animals that can live in any given area. Any animals above this number must leave or die.

The carrying capacity of an area is the largest number of animals of a species that a unit of habitat can support without deteriorating. Carrying capacity, expressed as density (e.g. 2 moose/km^2), is determined by food, water, shelter and space available, and varies as conditions change. In the north, the carrying capacity of any area can change drastically from year to year because of climatic variations or other factors such as forest fires.

The limiting factor in an area is the factor necessary to a species' survival that is in shortest supply.

f) Man-Made Changes in Habitat

Man affects animal numbers by changing habitat conditions and therefore altering the carrying capacity of the land. Human activities may either increase or decrease the carrying capacity of certain areas and for certain species; usually, however, decreases are the rule. Consider the effects of logging, mining, road-building, pipeline construction, and the expansion of communities.

Natality

"Changes in a population are brought about by births, deaths, and movement. When these are in balance, the population remains stable in size; when they are out of balance, it grows or declines. The production of new individuals by a population is termed the natality...." (Dasmann 1964)

Natality is governed by four main factors: size of litter, number of litters per year, minimum breeding age, and longevity.

Small mammals such as voles, shrews, mice and hares have relatively short life spans. In order to maintain their numbers they generally reach sexual maturity sooner and have more per litter than larger mammals. In addition, they often have several litters in a year. Their reproductive potential is therefore very high.

Larger mammals take longer to become adults and attain sexual maturity. They have only one litter per year and their litter size is generally less that smaller mammals. They are however longer-lived.

The shortness of the growing season in the north has a pronounced effect on natality. Small mammals found in both northern and southern Canada, such as the red squirrel and the muskrat, have less litters per year in the northern part of their range.

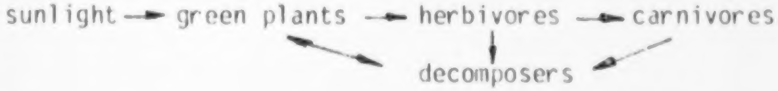
Fish produce thousands of eggs but only a small proportion of these reach maturity. In the NWT their productivity is considerably lessened. Colder waters result in a reduced growth rate and a later age for sexual maturity. For example, a 10-year-old lake trout in the United States may weigh 5 kg, but only 1 kg in the NWT. Sexual maturity is usually reached at age 6 or 7 in southern Canada, but not until age 13 in Great Bear Lake.

Mortality

Every animal species has a natural lifespan, but frequently it is not known with exactitude. Animals kept in captivity are often longer-lived than in the wild due to better nutrition and an absence of decimating factors. Old age is not a major cause of death in wildlife populations.

a) Predation

"With most wildlife, predation is an important decimating factor. Indeed, if the nature of biotic communities is considered, it will be recalled that predators play a normal role in such communities" (Dasmann 1964). This can be shown by the way in which energy flows through a community or an ecosystem:



This energy flow achieves a balance in the number of individuals which the community or the ecosystem can support at each level. If a species of herbivore becomes too numerous to be supported by the various plants it feeds upon, numerous individuals will die off until the balance is redressed. The same holds true for carnivores.

Predators also play a beneficial role by killing off diseased or weakened animals (the easiest ones to hunt), thus limiting or preventing the transmission of undesirable genetic characteristics. When prey populations expand, the number of predators also increases, thus working to prevent overgrazing of range. When prey populations decrease, predators also decrease.

Predators in the NWT include wolves, foxes, lynx, members of the weasel family, owls and raptors.

Note: When speaking of predators, we mean animal predators. Teachers should be aware, however, that hunting and trapping from the point of view of the wildlife manager have the same effect as predation.

b) Hunting & Trapping

Hunting and trapping can drastically affect population levels if more animals are killed than are added each year through natality. For example, plains bison, muskoxen, beaver, and caribou have all been seriously affected by over-harvesting.

However, controlled hunting and trapping may be used as a tool for managing wildlife. For example, a population of large herbivores may increase to a level that is beyond the carrying capacity of the land. If there is not enough food available to support the whole herd through the winter, large numbers of animals may grow weak and die, and they may also reduce the food supply so that it takes several years to return to its former level. Therefore, a reduction in the population is desirable.

c) Diseases & Parasites

"Most wild animals at most times are subject to various kinds of diseases and serve as hosts for numerous parasites. Most commonly an adjustment occurs between the host and the disease organisms or parasites.... Should an individual become weakened or injured, and its bodily resistance lowered, disease or parasitism can cause its death. With normal vigor, however, it resists infection.... The presence of disease organisms and parasites can thus serve as a check to prevent excessive destruction of the habitat by a host population, just as predators can, in theory, prevent a prey population from increasing to the point of habitat destruction." (Dasmann 1964)

Tapeworms can be found in many animals, including fish, birds and mammals. Another widespread parasite causes trichinosis not only in bears but also in a wide variety of mammals, including marine mammals. Warble flies are well-known parasites of caribou.

Diseases affecting northern animals include rabies (foxes, wolves, and other mammals), and tularemia (beaver, muskrat, and others). Bison are susceptible to anthrax, tuberculosis, and brucellosis.

d) Other Factors

Accidents are generally a minor cause of mortality among wildlife populations. A small number of caribou, for example, drown each year when migrating across bodies of water; in 1959, however, a herd inhabiting Bylot Island was reported to have perished while crossing the ice to the mainland. "Where man has introduced many modifications of the habitat, through buildings, roads, fences, and other artifacts, he increases the hazards for game animals. Most frequently it will be the young, inexperienced members of a population that are hardest hit by accidents." (Dasmann 1964)

Weather can also be a cause of mortality, especially in the north. Inclement weather, especially in the spring, can cause losses of young. In winter alternating warm and cold spells can result in the formation of an icy crust on top of the snow, which may hinder animals in foraging for food, or in escaping from predators.

Starvation is not common among herbivores, except under unusual winter conditions. It is more likely to occur among carnivores. "Most frequently, however, an animal will fall victim to predation, accidents, disease or parasitism before actual starvation takes place" (Dasmann 1964).

Some species are susceptible to mortality caused by stress. Excessive numbers in a population may cause overcrowding which results in sudden die-offs, even though an abundance of food, cover and water exists. This phenomenon, called "shock disease," is still not completely understood.

Rare, Threatened & Endangered Species

If a population declines to a very low level it may be in danger of dying out. A species that may be headed for extinction is termed an endangered species. An endangered population must produce more young than the total number of animals that died the previous year in order for population numbers to rise again.

A threatened species is one that is likely to become endangered if the factors affecting its vulnerability are not reversed.

A rare species exists in low numbers or in very restricted areas.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is a national organization responsible for identifying Canadian wildlife species in jeopardy. The following species occurring in the NWT have been listed:

Endangered:	bowhead whale wood bison whooping crane Eskimo curlew peregrine falcon (subspecies anatum)
Threatened:	Peary caribou peregrine falcon (subspecies tundrius)

Rare: great gray owl
ivory gull
Caspian tern

COSEWIC has published "summary sheets" on some of these species and more are in preparation. Teachers desiring copies for classroom use may contact the nearest Wildlife Officer, or the Office of Conservation Education, NWT Wildlife Service, Yellowknife.

Species Information

Species accounts are available from a number of sources. Three standard reference books, listed below, will be able to supply basic background information on all species of birds, mammals, and freshwater fish found in Canada. Cost is about $25 each, and all three are still in print.

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press. 438 pp.

Godfrey, W. Earl. 1966. The Birds of Canada. National Museums of Canada Bulletin No. 203. 428pp.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada Bulletin No. 184. 966 pp.

Information related specifically to species occurring in the NWT may be found in a series published by, and available from , the Science Advisory Board in Yellowknife:

Anonymous. 1980. Fish, Fur and Game in the Northwest Territories. Science Advisory Board of the Northwest Territories. 39 pp.

Davis, Rolph A., Kerwin J. Finley, and W. John Richardson. 1980. The Present Status and Future Management of Arctic Marine Mammals in Canada. Science Advisory Board of the Northwest Territories. 93 pp.

Dickinson, D.M. and T.B. Herman. 1979. Management of Some Terrestrial Mammals in the Northwest Territories for Sustained Yields. Science Advisory Board of the Northwest Territories. 71 pp.

McCart, P.J. and J. Den Beste. 1979. Aquatic Resources of the Northwest Territories. Science Advisory Board of the Northwest Territories. 55 pp.

The Department of Education has supplied to all schools the Arctic Wildlife poster series (10 posters depicting northern wildlife), and

10 booklets called Arctic Wildlife Teaching Notes which accompany the posters.

The Canadian Wildlife Service publishes a lengthy series of animal pamphlets under the general title of Hinterland Who's Who. Complete sets are available free to schools. Requests should be written on a GNWT letterhead and addressed to:

Distribution Section
Canadian Wildlife Service
Dept. of the Environment
Ottawa, Ontario
K1A 0E7

The NWT Wildlife Service has begun a similar series of animal pamphlets called the Arctic Wildlife Series. Copies may be obtained free from Wildlife Officers, or by writing to the office of Conservation Education, NWT Wildlife Service, Yellowknife.

Bibliography

In addition to the books mentioned in the previous section, the following were used to research this section:

Dasmann, Raymond F. 1964. Wildlife Biology. John Wiley & Sons. 231 pp.

Horwitz, Eleanor, ed. 1977. Ways of Wildlife. The Wildlife Society. Citation Press/Scholastic. 160 pp.

Smith, Robert Leo. 1974. Ecology and Field Biology. Harper & Row. 850 pp.

Vaughan, Terry A. 1972. Mammalogy. W.B. Saunders Co. 463 pp.

WILDLIFE MANAGEMENT

In the natural pattern of things, all living species are constantly evolving into new forms. This process occurs over a period of thousands of years, and is a response to changing environmental conditions. Variations in climate and vegetation must necessarily have a profound effect on resident wildlife populations. These populations must either adapt or emigrate to more suitable areas. Populations or entire species which fail to meet these challenges to their survival will suffer declines and, ultimately, extinction.

In the last 300 years competition between wildlife and man has escalated alarmingly. Since 1600 the number of people in the world has quintupled. The resulting demand for wildlife (in the form of meat, fur, and other by-products) has encreased accordingly. In North America, market hunting extirpated the passenger pigeon and nearly wiped out bison. Even today, commercial whaling and ivory poaching have seriously depleted several species of whale and the African elephant.

But perhaps the most serious threat to wildlife is the loss of habitat. An expanding human population requires land for cities, towns, farms, roads and livestock. Consequently, the range and numbers of many wildlife species in North American have diminished accordingly.

This trend is not going to reverse itself. It is clear, therefore, that man must take a direct hand in preserving wildlife. Perhaps nowhere else in North America is the challenge as great as in the N.W.T. Here is one of the last great refuges for wildlife; where wildlife still outnumbers and outmasses the human population; where a majority of the population still depends on wild meat for sustenance, and on animal products (notably fur) for a livelihood; and where the predominant cultures are closely linked with wildlife populations. Balanced against this is the vast mineral and petroleum wealth in the N.W.T. awaiting exploitation.

The minimum goal of wildife management, therefore, is to maintain present numbers and diversity of wildlife for human use and enjoyment -- in the face of escalating utilization and diminishing habitat.

Research

In order to make intelligent management decisions, wildlife managers must first have a thorough (and often intimate) understanding of the animals they seek to preserve.

a) Taxonomy

The study of wildlife starts with the identification of species. Differentiation is based on observable characteristics -- an apparently easy task at first glance. People have, after all, been doing this throughout recorded history without the aid of scientists. But each member of a species is an individual organism, not an exact copy of its neighbour. At some point in time the trend of differences in a population becomes significant enough to separate it from other populations of the same species. Thus subspecies are formed; these, in time, may eventually evolve into distinct species.

The dilemma of the taxonomist consists of where to draw lines among various taxa (e.g. subspecies, species, genus, etc.), and of which criteria to use. Sometimes the results are less than obvious; a red fox and a cross fox, for example, are but colour phases of the same species, while a white fox belongs to a different species. To the untrained observer, a rock ptarmigan and a willow ptarmigan may be virtually indistinguishable, yet they belong to separate species. Some of the bases for such distinctions are variations in anatomical, genetic, morphological and behavioural features.

Equally important is the naming of species -- again a deceptively easy task -- for even within the same country a single species may have many different common names. In fact, it was not until the 18th century, when Linnaeus introduced the binomial system of nomenclature, that scientists could be certain they were talking about the same species.

To sum up:

> Taxonomy is the theory and practice of classifying organisms, of characterizing species and arranging them in hierarchies of higher categories ... The taxonomist usually attempts to place the units and groups in some natural order that will show relationships and phylogeny (evolutionary history). (Smith 1974)

For the purposes of instruction at this level, a species may be defined as a group of individuals able to breed among themselves but not with organisms of other groups. For further information on taxonomy, teachers may refer to section L7-3.

b) Anatomy and Physiology

A sound knowledge of anatomy and physiology is a basic requirement for all wildlife managers. This knowledge assists taxonomic classification, supplies information on the condition of animals, and provides methods for determining sex and age.

Closely related to these disciplines are pathology and parasitology. Pathology is the study of diseases and diseased tissues, of which parasites are often the cause. Most animals, at one time or another in their lives, are afflicted by parasites.

If desired, teachers may call on Wildlife Officers to assist in the dissection of animals.

c) Habitat Studies

Habitat refers to the total of environmental factors (food, cover and water) required for the maintenance of a given species. A prerequisite for understanding these factors is a knowledge of geology, topography, soils, weather and climate, history of the area, and plant biology -- to name a few.

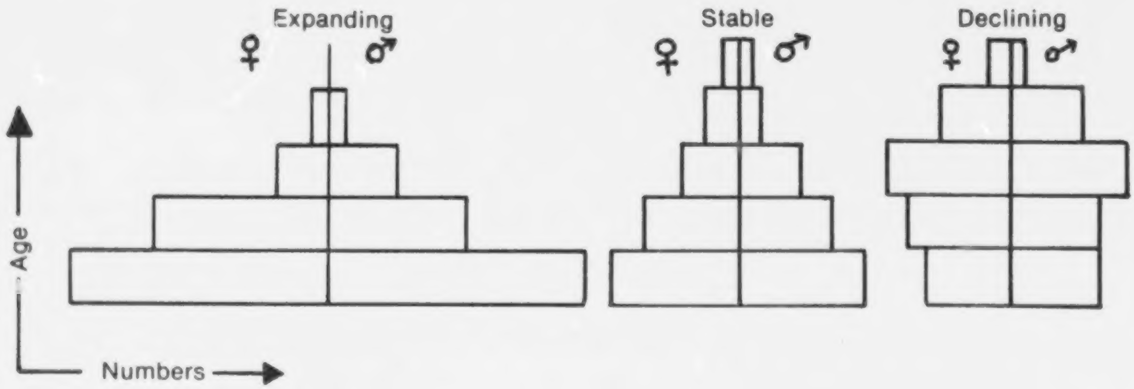
Many systems of classifying habitat types have been devised, as well as methods of measuring the components of plant communities. Remote sensing (the use of cameras and other recording equipment carried in aircraft or spacecraft) is one way in which vegetation can be mapped. Specific habitat studies may also be undertaken to determine the amount of forage available to a species, as well as the amount of food actually utilized (e.g. stomach and scat analysis).

As an example of the practical application of these techniques, the Belcher Islands reindeer transplant may be cited. Prior to the transplant, a range study was undertaken to determine the amount of winter and summer forage in order to ensure that food was available in sufficient quantities for the survival of the reindeer.

d) Age and Sex Criteria

The wildlife manager needs "to be able to determine the sex and age of a large sample of each species under study or management because this is an important basis for determining the current condition of animal populations and predicting the fate of that population in the near future" (Larson and Taber in Schemnitz 1980).

Numerical relationships between the sex and age of individuals in a population is termed its structure, and can be portrayed graphically:



These are called sex-and-age pyramids, and enable us "to analyze the history of a population and determine its probable future developmennt" (Dasmann 1964).

Age is also important in determining reproductive potential, since different species take varying lengths of time to become sexually mature. Equally important is learning the sex ratio of a population, for the greater the number of females in a population the greater its reproductive potential is.

i) Sex

Determining the sex of an animal can be done easily enough by dissection, but obviously this technique cannot be employed on live animals. The sex of captured animals can be determined by palpation or close visual inspection, but capturing animals simply to ascertain sex is not practical or economic. Identifying from a distance external characteristics which differentiate the sexes is a fine art, and even then is not possible for many species -- especially since juvenile animals of many species closely resemble adult females. The time of year when such observations are made is important -- in summer, for instance, a caribou accompanied by a calf is obviously a female.

ii) Age

Determination of age is equally difficult. Methods for measuring age have been confirmed for many species, while for others they are still unknown or uncertain. Tooth eruption for many ungulates can give the exact age in months, but only up to a certain age, e.g. for caribou up to about 24 months.

Exact age for many species can be determined by counting annuli - annual growth rings deposited by various physiological features - but this can only be done in the laboratory. Teeth may be used for many animals: second or third incisor for caribou, first premolar for polar bear, canine for wolverine. The same method can be employed on the scales of fish if the scales are large enough (e.g. whitefish), or on otoliths (a granule of calcium carbonate in the inner ear) for other species (e.g. lake trout). Other methods for estimating age include pelt examination, weight of eye lens, weight of baculum, and tooth wear patterns.

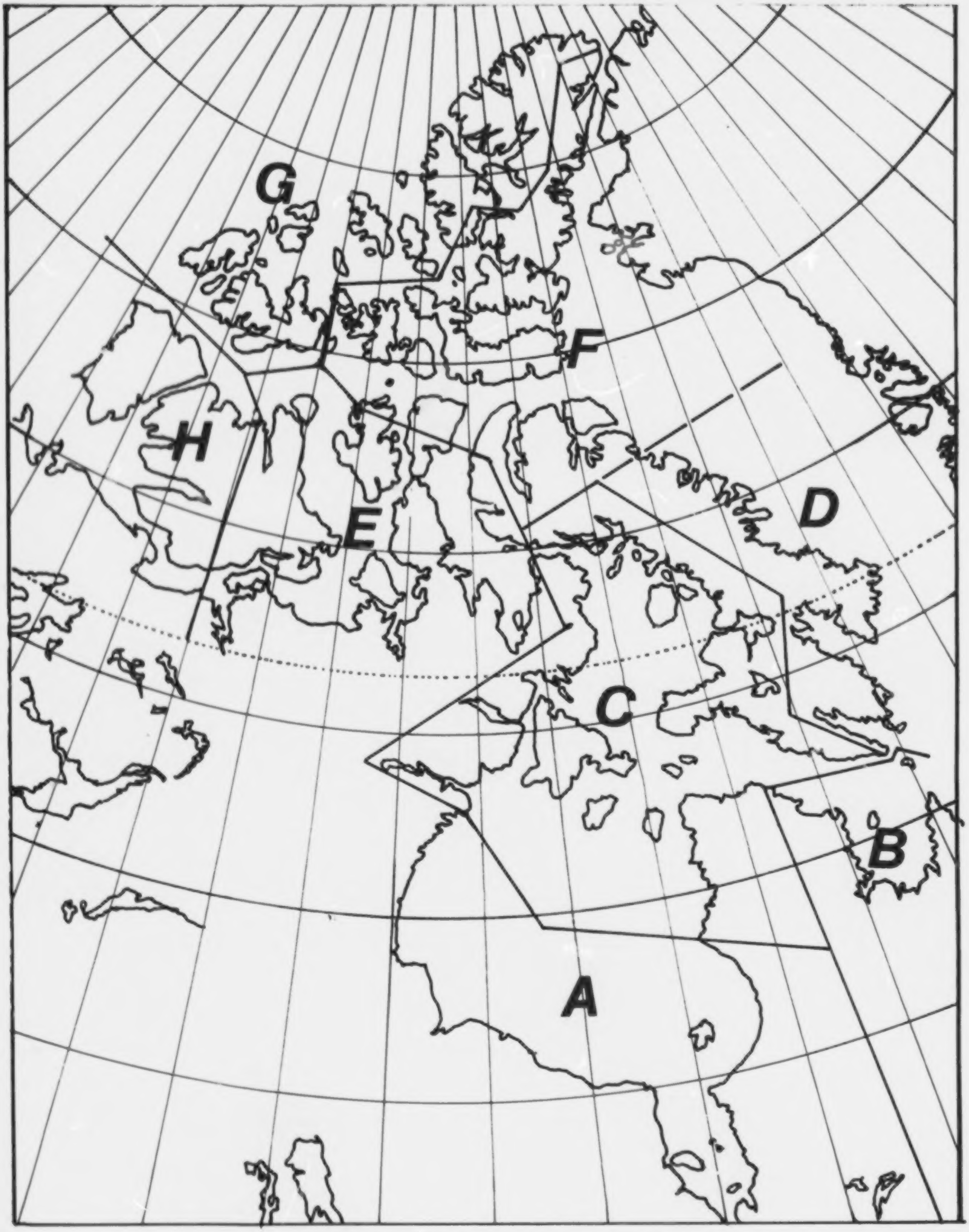
These methods cannot be employed on live animals - except in the case of polar bears. When a polar bear is immobilized, the first premolar (a small non-functional tooth) is extracted and later analyzed.

Fortunately for the purposes of wildlife management, knowing the exact age is not usually necessary. Caribou may be aged visually in the field by experienced observers, since no more than four age classes are generally required: calf, yearling, two-year-old, and adult.

For many other species only two age classes are required: juvenile and adult. For most species of birds, plumage differences and feather wear may answer this purpose.

e) Movement and Migration

It stands to reason that wildlife managers must know the location of the animals they wish to manage. The marking of wildlife helps to determine the range and distribution of species and populations. Waterfowl are banded, while fish and terrestrial mammals such as caribou and polar bear are tagged. Such studies have helped delineate barren-ground caribou herds and polar bear populations.



CANADIAN POLAR BEAR POPULATIONS

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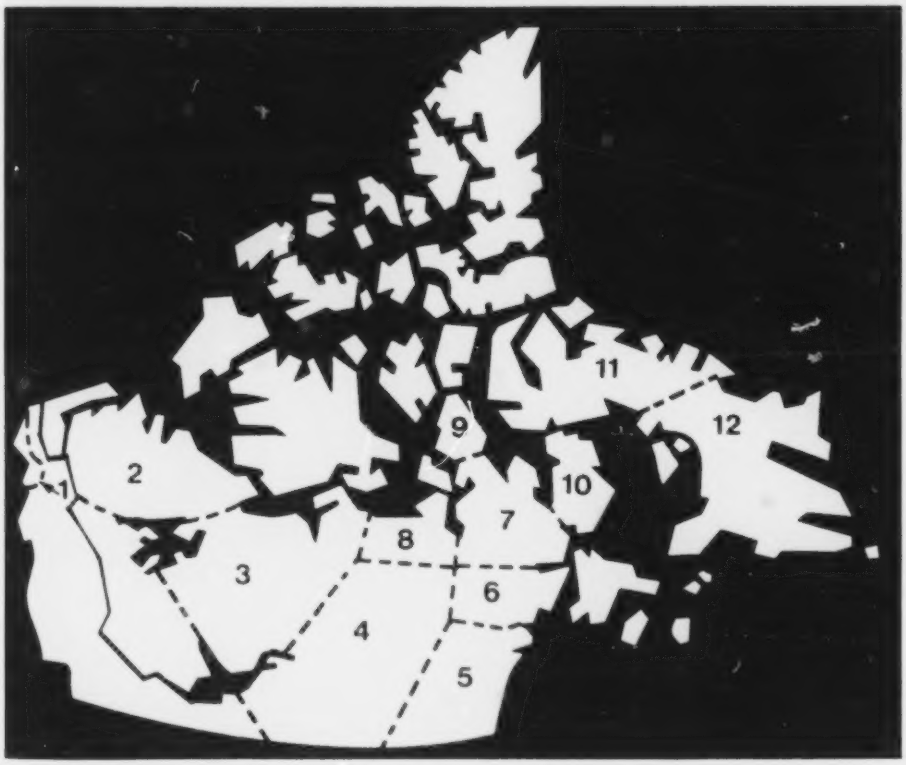


Barren-ground caribou herds in the N.W.T.

Major herds: 1. Porcupine 2. Bluenose 3. Bathurst 4. Beverly 5. Kaminuriak
Other populations tentatively identified as herds: 6. Lorillard 7. Wager
8. Queen Maud 9. Boothia 10. Melville 11. North Baffin 12. South Baffin

Caribou tagging is done in the summer at water crossings. Boats approach swimming caribou, which are captured with the use of a shepherd's crook and held immobile against the side of the boat for a few moments while a tag is inserted in an ear, or a collar placed around the neck.

Polar bear tagging is usually done in late winter or early spring. Polar bears are immobilized by means of a drug-filled dart fired from a low-powered rifle at close range (usually from a helicopter). Once a bear has been immobilized, tags are inserted in its ears, and its inner lips are tattooed.

A more recent technique involves the placing of a radio transmitter in a collar around the neck of an animal, and monitoring movements either by aircraft or satellite. This has been done for both wolves and polar bears in the N.W.T. The collars are designed to fall off after a certain length of time.

When tagged, banded or collared animals are captured or harvested, the range of populations can be established. (See "Harvest Data" following.)

f) Numbers

For the wildlife manager the most immediate question is often, "How many are there?" Counting animals has become a science in itself and involves the heavy use of statistical analysis, since complete counts are usually impossible.

Aerial surveys are the best known method of counting animals, but the principles underlying them are not equally well-known. Aerial surveys can only be employed for animals large enough to be visible from the air, and usually only for ungulates which form herds in open areas. In the N.W.T. the species most commonly surveyed in this way are muskox, bison and caribou.

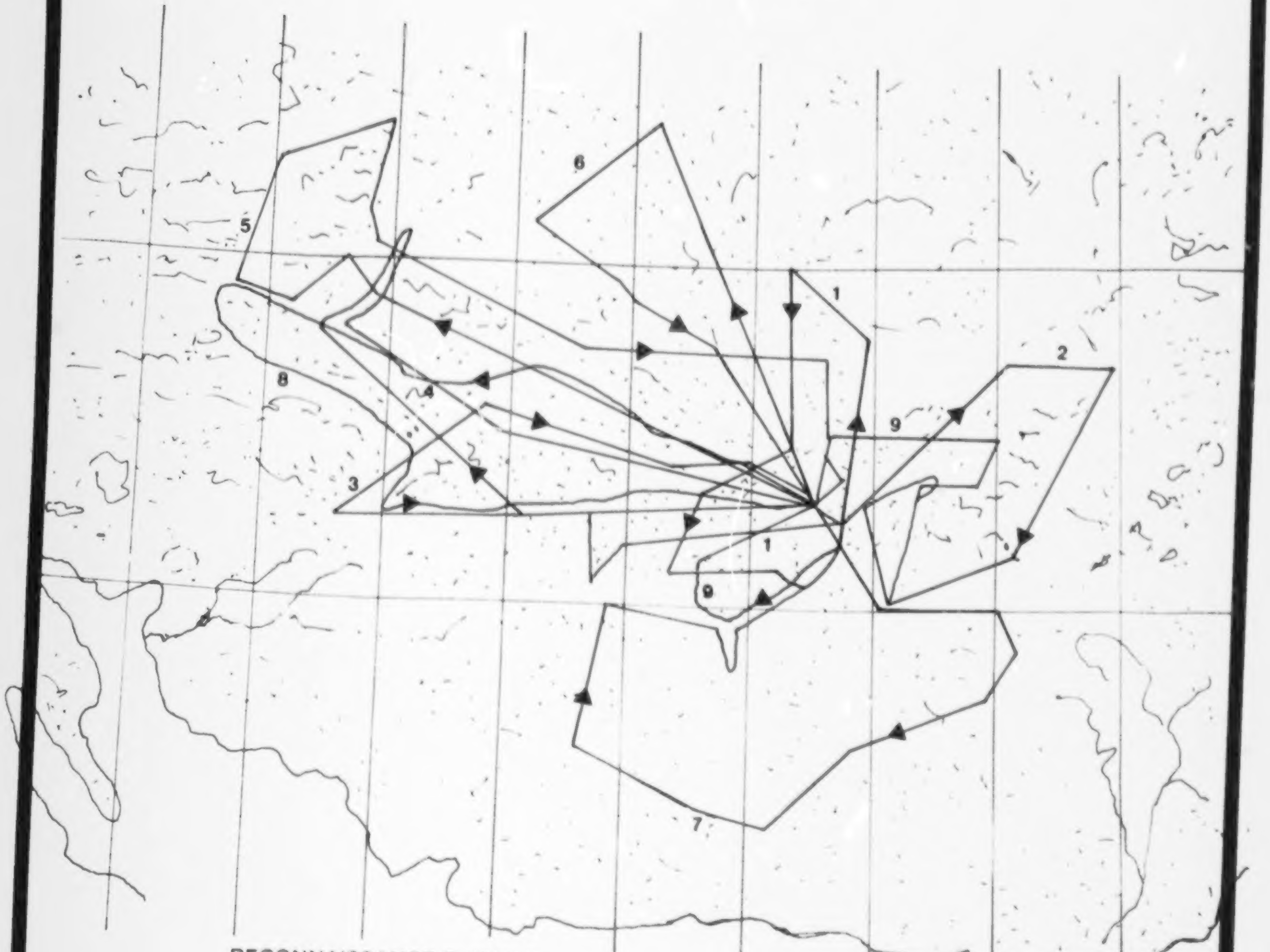
i) Caribou Surveys

Except in the spring, a caribou herd is generally spread out over too vast an area to be counted accurately and economically. By early June, however, cows from each herd have congregated on calving grounds -- giving biologists their best opportunity for counting animals.

The first step in a calving ground survey is reconnaissance, since the precise location of calving grounds may vary from year to year. The object of this portion of the survey is simply to define the boundaries of the calving ground.

The second step involves actual counting. But since even calving grounds are too extensive for complete counts, only portions are surveyed. Equidistant transects are flown throughout the entire calving ground, but only caribou within 400m of either side of the plane are counted. (At the same time they are also classified according to age and sex.)

When the survey is completed, an estimate of the total number of caribou on the calving ground is computed, based on the number actually counted and the area surveyed.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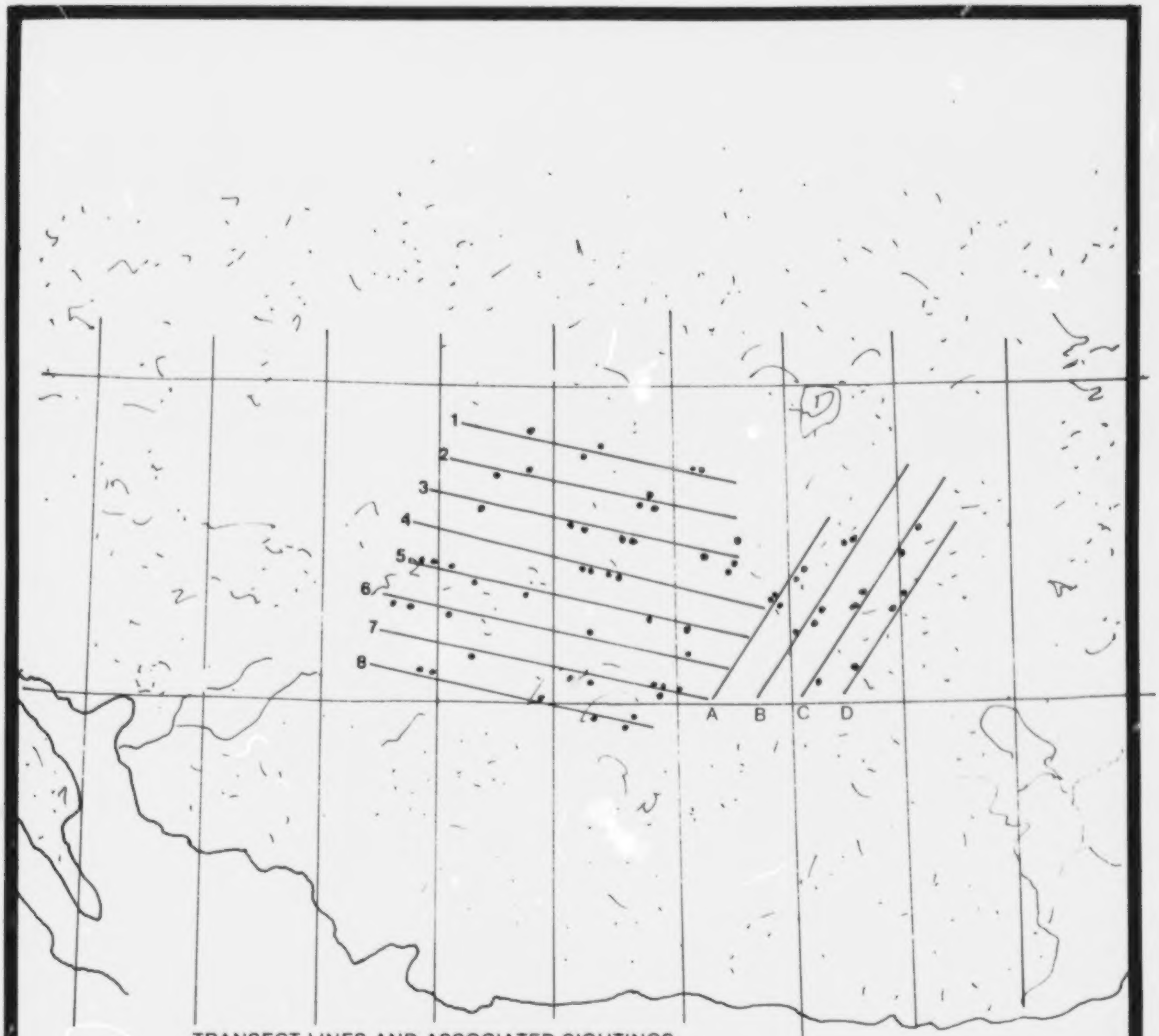
RECONNAISSANCE FLIGHTS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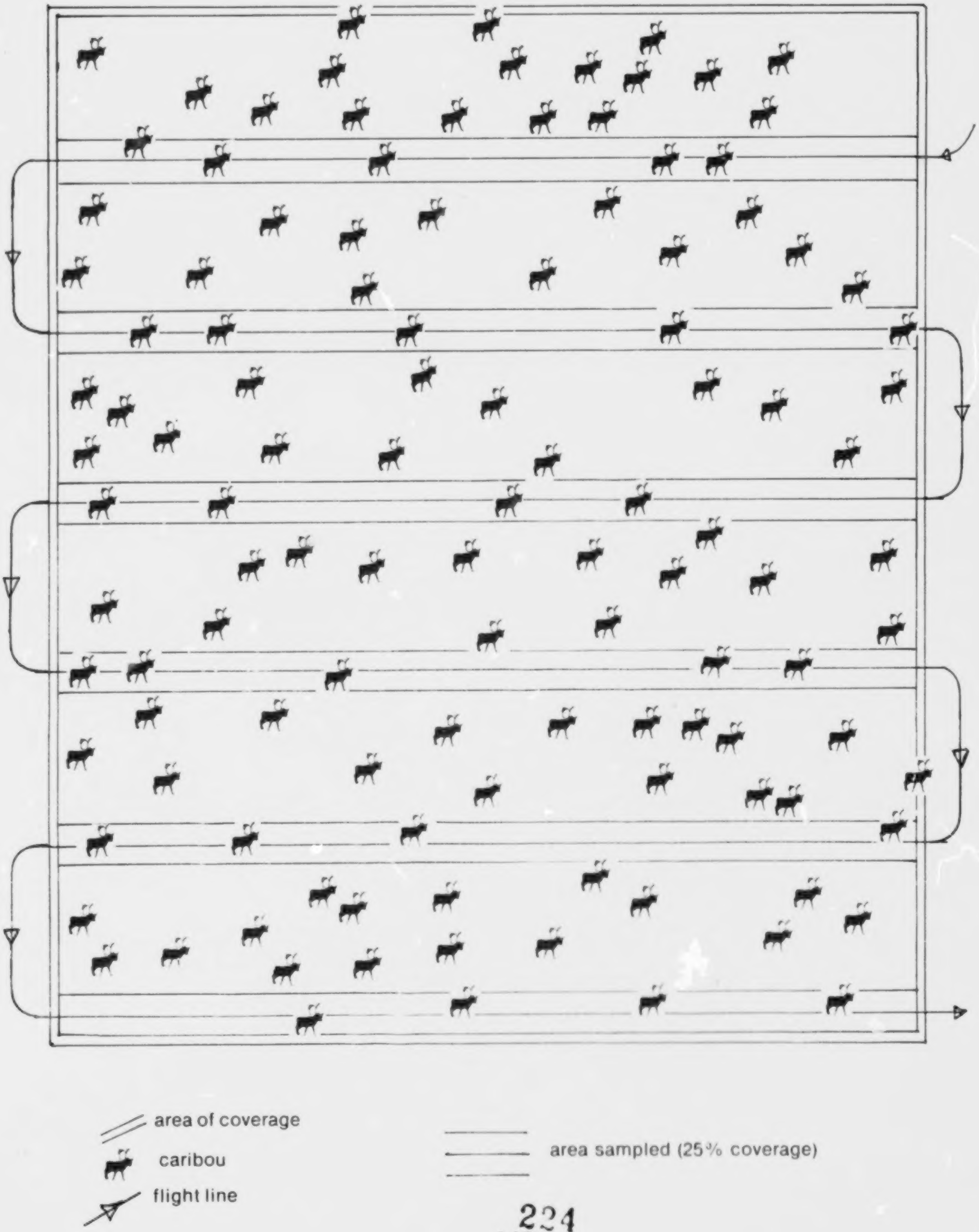
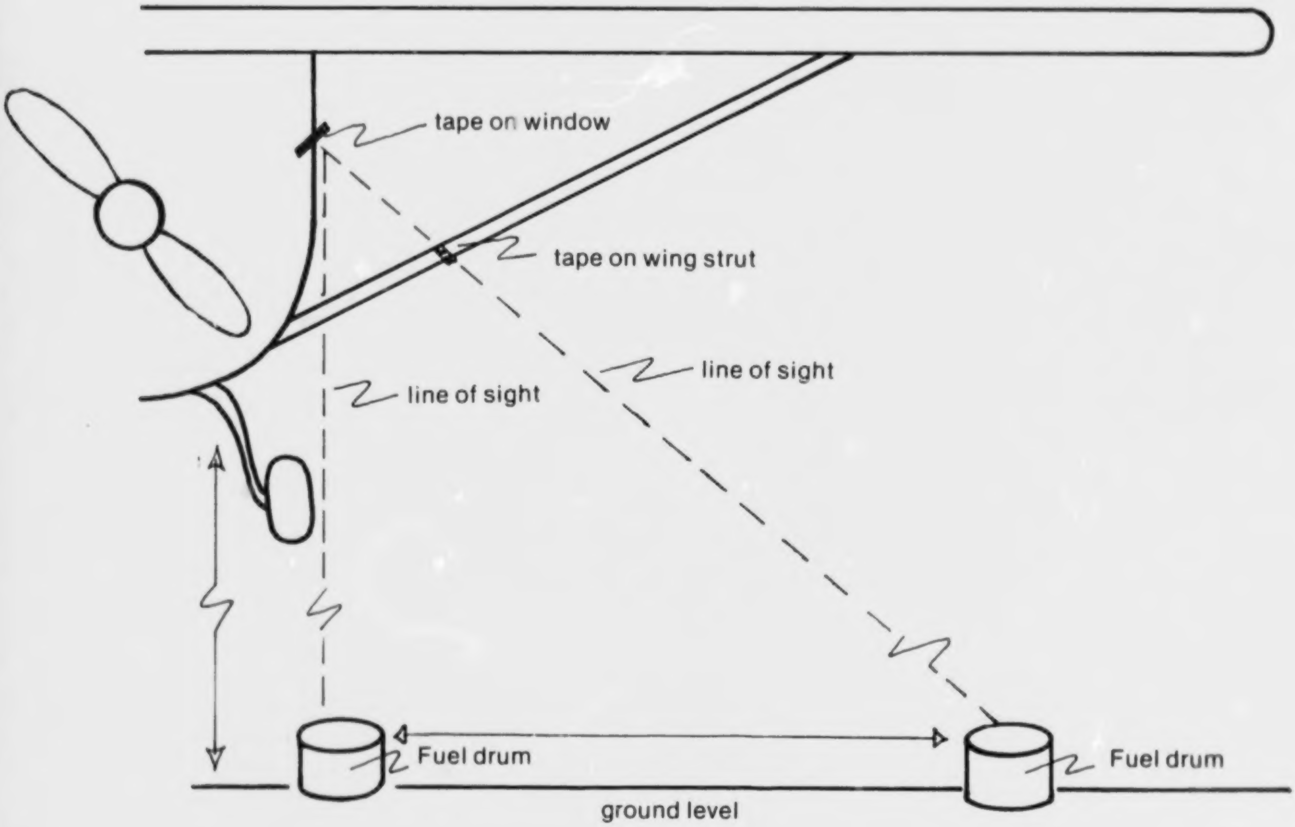
TRANSECT LINES AND ASSOCIATED SIGHTINGS

DETAILED EXAMPLE OF TRANSECT PORTION OF AN AERIAL SURVEY:


area of coverage
caribou
flight line
area sampled (25% coverage)

If a survey went according to the last figure above, 27 caribou would have been actually counted. Since coverage was 25%, the total population estimate is (4 x 27 =) 108. (Note: a complete count reveals a population of 117).

The validity of this method rests on a number of variables, one of the most important being the ability of the observers to estimate a distance of 400m. In order to ensure accuracy, this distance is marked out on the ground (e.g. by fuel drums). The aircraft then flies over the drums at a fixed altitude so that the observer on one side (and then the other) is able to mark the distance - usually by fixing a strip of tape to the window so that it lines up with another strip of tape previously affixed to the wing strut on his side, and with one of the drums on the ground (the other drum being directly below the observer at the moment of alignment).



Equally important is the ability of the pilot to maintain a fixed altitude (usually 120m) above ground level (often over terrain which is abrupt and rugged), and to maintain a fixed speed throughout the course of the survey to give observers an equal amount of time to observe caribou over all parts of the calving ground.

The ability of observers is also important. They must be able to:

1) remain alert during long periods of flying while sitting in a cramped position;

2) sight caribou which are standing up or lying down, against backgrounds of both snow and bare ground;

3) count rapidly and accurately (or estimate when necessary) groups of caribou which may number in the tens or hundreds, but only those within the artifically imposed boundary during the few seconds it takes the aircraft to pass them;

4) and finally to differentiate between cows, bulls, yearlings, and calves from the air.

In addition to the pilot, at least three others are required for a survey of this sort. Two observers sit to the left and right in the rear of the plane. Next to the pilot sits a navigator, holding a map of the area on which predetermined flight lines or transects have been drawn. It is the navigator's duty to assist the pilot in remaining on course, and to record sightings on the map. The procedure is as follows:

1) on sighting caribou within the 400m boundary, an observer calls for a number;

2) the navigator, beginning the survey at number 1, calls out the appropriate number and records it at the same time on the map in the correct location;

3) the observer activates his tape recorder, cites the number given him by the navigator, and records the number of caribou he has observed, e.g. 5 cows, 3 calves and 1 yearling.

When the day's flight is over, the observers must transcribe their observations from tape to paper (transect coding sheets). At the end of the survey, the biologist in charge tabulates the data recorded on all the sheets and calculates a population estimate of caribou on the calving ground.

However, a calving ground survey only gives an estimate of a portion of the herd -- cows and calves.

TRANSECT CODING FORM

DAILY CODE FORM NO.: ______________________

STRATUM: ______________________

DATE: ______________________

OBSERVER: ______________________

TRANSECT: ______________________

TRANSECT LENGTH ______________________

PERCENT SNOW COVER: ______________________

	locn pt #	Caribou	Calves	TOTAL	locn pt #	Caribou	Calves	Total
TOTALS								

PAGE TOTALS ______________________

DAILY CODE FORM

DAILY CODE FORM NUMBER: ______

DATE: ______

HERD: ______

SURVEY TYPE: ______

CREW:
— PILOT ______
— NAVIGATOR ______
— LEFT OBSERVER ______
— RIGHT OBSERVER ______

AIRPLANE: ______

ALTITUDE: ______
______ m

AIR SPEED: ______
______ km/h

STRIP WIDTH: ______
______ km each side

FLYING TIME: ______

WEATHER:
— CLOUD ______
— TEMP ______
— WIND ______

TRANSECTS FLOWN: ______

MAPS USED: ______

CARIBOU VISIBILITY: ______

GENERAL SNOW AND ICE CONDITIONS: ______

NOTES:

TRANSECT SUMMARY

SURVEY TYPE: ______________________________

DATES: ______________________________

BASE LINE LENGTH: __________ km N= __________ STRATUM AREA: __________ km²

____

TRANSECTS FLOWN (n) = ______________________________

	Tran #	Length (km)	Area (km²)	Number of non-calves counted		Total
				Left Obsr.	Right Obsr.	
TOTALS						

(During calving, bulls and most yearlings occupy an area outside the calving ground.)

To generate a total population estimate, the ratio of bulls to cows must be obtained. This is done in the fall at the time of the rut, when cows and bulls are evenly distributed throughout the area occupied by the herd. An aircraft (usually a helicopter) is used to land observers near as many groups of caribou as possible. Using spotting scopes, the observers classify caribou according to age and sex. The derived sex ratio is then combined with the estimated total number of cows (from the calving ground survey) to produce a total population estimate. Other data, such as population structure, calf survival, etc., are also obtained.

ii) Polar Bear Surveys

The methods described above cannot be used for polar bears, since these animals are generally solitary. Population estimates are therefore derived from data obtained through tagging and recapture studies.

This method can be demonstrated in the following way:

1) Fill a large jar with white beans. Let the beans in the jar represent a population of polar bears.

2) Remove a handful of beans and count them. Replace them with an equal number of coloured beans. Let the coloured beans represent the number of bears captured and tagged in a year.

3) Put the coloured beans in the jar and mix thoroughly with the other beans.

4) Remove another handful of beans. Let these beans represent the number of bears captured in the following year for tagging. Most of the beans will be white, but some will be coloured (i.e. most of the bears captured in the second year will be new bears, but some will have been already captured and tagged in the first year).

5) Let the ratio of coloured to uncoloured beans in the second handful be equal to the ratio of all coloured to all uncoloured beans in the jar. An estimate for all beans in the jar can then be obtained. For example:

first handful - 76 beans (coloured) = T

second handful - coloured beans 15 = t
- uncoloured beans 67 = U

The estimate for total uncolored beans in the jar is:

$$\frac{U \times T}{t} = \frac{67 \times 76}{15} = 339$$

The estimate for all beans in the jar is then (339 + 76) 415.

6) Now count all the beans in the jar and see how close your estimate is.

Teachers using this test will note that any given second handful of beans will produce a different estimate. They will note, however, that by replacing successive handfuls of beans with coloured beans, the estimate becomes more and more accurate. In other words, the more times a particular population of bears is tagged (i.e. the larger the sample becomes), the more accurate the population estimate becomes.

The variation among handfuls can be measured by the application of statistical formulae. It is extremely important for biologists to be able to measure the accuracy of their estimate. For example, the confidence limits at the 95% level may be calculated in the following way:

$$S.E. = 2N\sqrt{\frac{(N-T)\ (N-n)}{Tn\ (N-1)}}$$

Where S.E. = standard error at the 95% confidence limit
N = population estimate
T = number of marked individuals
n = total individuals in second sample
t = number of marked individuals in second sample

Using the numbers given in the example above:

$N = 415 \quad T = 76 \quad n = 82 \quad t = 15$

$$S.E. = 2(415)\sqrt{\frac{(415 - 76)\ (415 - 82)}{(76)\ (82)\ \ (415 - 1)}} = 174$$

Upper limit = 415 + 174 = 589
Lower limit = 415 - 174 = 241

The chances are therefore 95 out of 100 that the population lies between 241 and 589.

iii) Trend Data

New techniques for more accurately determining population numbers are constantly being investigated. While present methods are not perfect, they do present us with trend data, which provide a sound basis for wildlife management. A population estimate is never 100% accurate, but if the same techniques are applied year after year, trends can be established -- i.e. a population will be found to be stable, declining or increasing. It is on this basis that management decisions can be made.

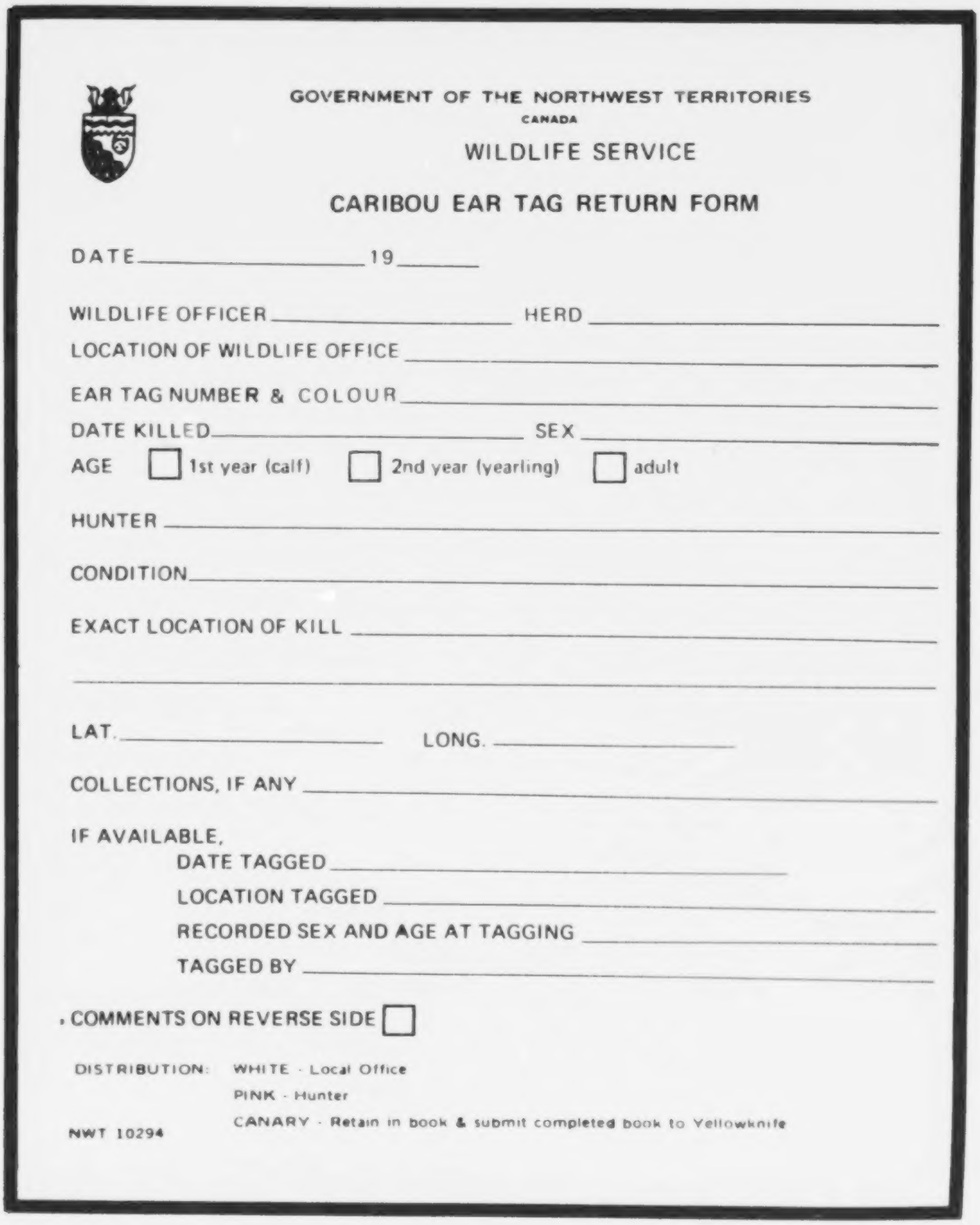
g) Harvest Data

Wildlife managers must know both the amount and the cause of mortality in a population. Since hunting and trapping are major causes of mortality, the collection of harvest statistics is an important task for wildlife managers. Kill data are recorded annually when hunting licences are renewed, while fur traders are required by law to keep accurate records of the fur they have purchased. The Baffin Regional Inuit Association (BRIA) is also undertaking a detailed harvesting study. Teachers in Baffin Region should contact the local BRIA representative for details of this study.

Polar bear returns have been systematized so that they can be stored in computers, where they are available for instant retrieval. Special forms are also used to record the harvest of tagged caribou.

Other causes of mortality are disease, parasitic infestation, pollution, habitat destruction and predation. It is the duty of the Wildlife Service to investigate all such causes.

Note: Teachers should emphasize the fact that wildlife research in the N.W.T. is never undertaken purely as an end in itself. Its purpose is to provide wildlife managers with the information necessary to make decisions on how best to conserve wildlife for the benefit of all people. The kinds of decisions which may be made to accomplish this are given in the section immediately following.



GOVERNMENT OF THE NORTHWEST TERRITORIES
CANADA

WILDLIFE SERVICE

CARIBOU EAR TAG RETURN FORM

DATE ______________ 19 ______

WILDLIFE OFFICER ______________ HERD ______________

LOCATION OF WILDLIFE OFFICE ______________

EAR TAG NUMBER & COLOUR ______________

DATE KILLED ______________ SEX ______________

AGE ☐ 1st year (calf) ☐ 2nd year (yearling) ☐ adult

HUNTER ______________

CONDITION ______________

EXACT LOCATION OF KILL ______________

____

LAT. ______________ LONG. ______________

COLLECTIONS, IF ANY ______________

IF AVAILABLE,

DATE TAGGED ______________

LOCATION TAGGED ______________

RECORDED SEX AND AGE AT TAGGING ______________

TAGGED BY ______________

COMMENTS ON REVERSE SIDE ☐

DISTRIBUTION: WHITE - Local Office
PINK - Hunter
CANARY - Retain in book & submit completed book to Yellowknife

NWT 10294

GOVERNMENT OF THE NORTHWEST TERRITORIES
CANADA

POLAR BEAR
COMPUTERIZED HUNTER KILL RETURN SHEETS

DATE

Please print all information in block letters. Refer to the guide on reverse side for detailed instructions in completing each line. Key words are for key punching instructions only and may be disregarded. * These lines must be completed.

LINE NO	DESCRIPTION	KEY WORD	DATA
1 *	EAR TAG NUMBER	TAG 1	LF X
2	EAR TAG NUMBER	TAG 1	RF X
3	EAR TAG NUMBER	TAG 1	LB X
4	EAR TAG NUMBER	TAG 1	RB X
5 *	LIP TATOO NO	TAT	X
6	PAINTED MARKS	MK	
7 *	COLLECTOR	COLL	
8 *	HUNTER'S NAME	HUN	
9	HUNTER'S LICENCE NO.	HUNLIC	
10 *	HUNTER'S TOWN	TOWN	
11 *	HIDE TAG NO	HIDELIC	
12 *	TYPE OF KILL	REA	K REG K SPORT K PROBLEM K ILLEGAL K NATURAL
13 *	KILL DATE	DATE	
14 *	LOCATION	LOC	
15 *	LATITUDE	LAT	
16 *	LONGITUDE	LONG	
17 *	SEX	SEX	M F U
18 *	SPECIMENS	OSPEC	JAW
19	ESTIMATED AGE	EAGE	CUB 1 2 YR. SUB ADULT 3 4 YR. ADULT 5 YR+
20	COMMENTS	GEN	

OFFICE USE ONLY

	KEY NUMBER	KEY	
	ORIG TAG NO	NUM	X
	LABORATORY NO.	LAB	
	LABORATORY AGE	AGE	
	AGE CLASS	CLASS	
	TOOTH	TOOTH	
	DIST'N ZONE	ZONE	

NWT 1021/0[illegible]

234153

Management

Although people have studied animals for centuries, the modern science of wildlife management orginated during the present century. Initially it went through a period of strict protectionism -- attempts were made to eliminate hunting, predation and competition from other species. In some cases, the results were the complete opposite of those desired; the control of all limiting factors led to an increase in population size, but where these increases outstripped the carrying capacity of the land, starvation ensued and the populations crashed, sometime below their original level.

This led to the concept of sustained yield -- where harvest equals recruitment. If no other decimating factors are involved, a population managed on the basis of sustained yield will remain numerically stable. The use of controlled harvests through hunting and trapping is therefore a recognized method of wildlife management. By varying the level of harvest, a population can be allowed to expand up to the carrying capacity of the area it inhabits, or prevented from increasing beyond that point. At the same time, this allows the human exploitation of animals which would otherwise be lost through natural mortality.

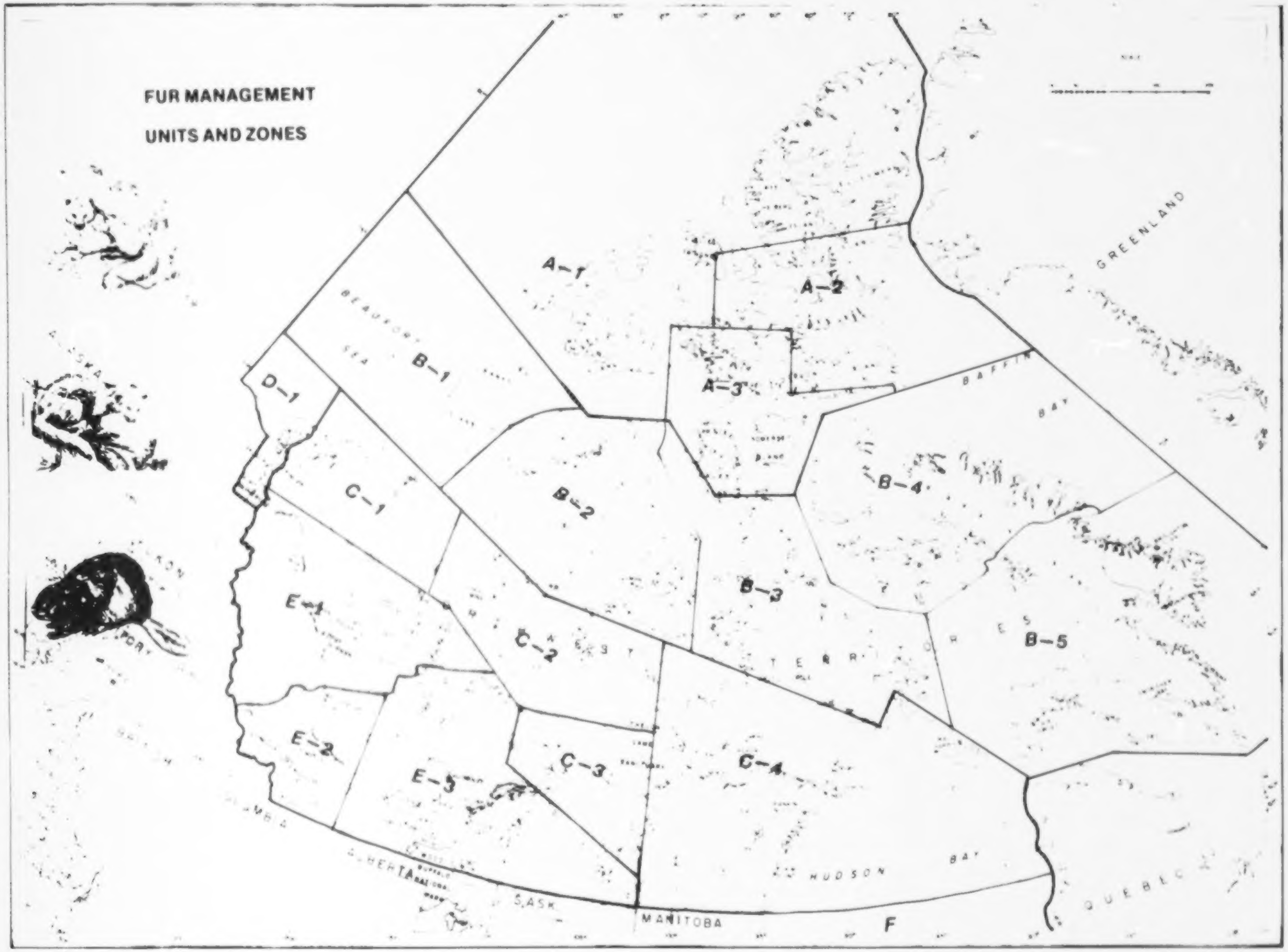
a) Harvest Controls

Controls on hunting and trapping are obtained through the imposition of licence requirements, seasons and limits. In the N.W.T. there are two main kinds of licences issued under the authority of the Wildlife Ordinance: General Hunting Licences (for native people and a few long-term northerners) and Sport Hunting Licences (for others).

Under the N.W.T. Act (which takes precedence over the Wildlife Ordinance), native people may hunt for food without being bound by seasons and limits -- except in the case of polar bear, muskox, wood bison and caribou populations on Coates and Southampton Islands. Trapping, which is a commercial enterprise involving the hunting of fur-bearers, for the purpose of trafficking in furs, is regulated mainly through the establishing of open and closed seasons.

Sport hunters face the stiffest eligibility requirements in all of Canada -- to qualify as a "resident", a sport hunter must have resided continuously in the N.W.T. for a period of two years. Sport hunters must also abide by seasons and limits for most game in the N.W.T.

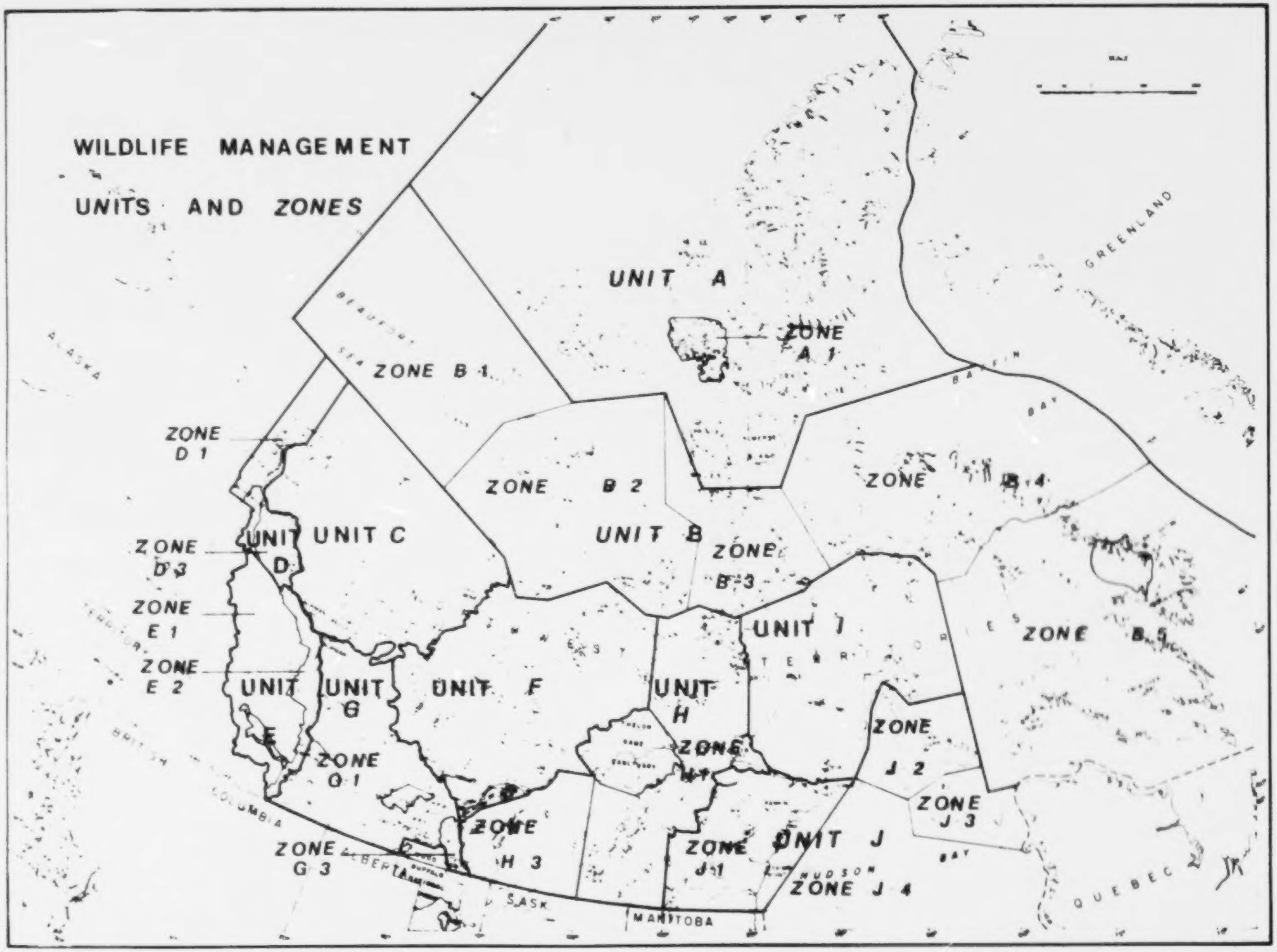
Seasons are stipulated to allow animals an undisturbed period to rear their young. Limits or quotas may be made on an individual basis (so many per hunter, in the case of sport hunters), or by area or community (as with muskox and polar bear).


FUR MANAGEMENT

UNITS AND ZONES

A-1
A-2
A-3
B-1
B-2
B-3
B-4
B-5
C-1
C-2
C-3
C-4
D-1
E-1
E-2
E-3
F
BEAUFORT SEA
BAFFIN BAY
GREENLAND
HUDSON BAY
QUEBEC
MANITOBA
SASK.
ALBERTA
COLUMBIA
YUKON
ALASKA
TERRITORIES

BEST COPY AVAILABLE



WILDLIFE MANAGEMENT UNITS AND *ZONES*

UNIT A
ZONE A 1
GREENLAND
BEAUFORT SEA
ZONE B 1
ALASKA
BAFFIN BAY
ZONE D 1
ZONE B 2
UNIT B
ZONE B 3
ZONE B 4
ZONE B 5
ZONE D 3
UNIT D
UNIT C
ZONE E 1
ZONE E 2
UNIT E
UNIT G
UNIT F
UNIT H
UNIT J
NORTHWEST TERRITORIES
YUKON TERRITORY
BRITISH COLUMBIA
ZONE G 1
ZONE H 1
ZONE J 2
ZONE J 3
ZONE G 3
ALBERTA
ZONE H 3
ZONE J 1
UNIT J
HUDSON BAY
ZONE J 4
SASK.
MANITOBA
QUEBEC

To recognize the existence of a number of wildlife populations, hunting and trapping zones have been established for big game and fur-bearing species in the N.W.T. This enables wildife managers to apply varying seasons and limits, as necessary, for different areas.

Other restrictions may be based on sex (e.g. for Dall's sheep, sport hunters may take only rams), or size (e.g. polar bears).

b) Habitat Protection

Protection, maintenance, and enhancement of habitat is one of the most important functions of the wildlife manager -- for without suitable habitat, wildlife cannot survive. In the N.W.T., land use permits are required for activities which alter the habitat -- road building, pipeline construction, seismic operations, mining, logging, exploration, etc. The N.W.T. Wildlife Service assesses applications for land use permits and makes recommendations designed to diminish the impact on wildlife. Final approval for such applications, however, rests with the Federal Government.

Another aspect of habitat protection is the control of wildfire.

c) Predator Control

The pupose of predator control is to reduce the mortality incurred by a declining prey species. When speaking of predators in this context, we are almost always referring to wolves. In the past, wolves have been controlled by poisoning programs and bounty hunting. It must be remembered, however, that predators and their prey existed in balance long before the intervention of man. While wolves may be a contributing factor in the decline of a prey species, they are seldom the sole or even main cause. Consequently, predator control is now-a-days used only as a last resort.

d) Wildlife Transplants

An obvious solution to declining or extirpated populations is the transplanting of wildlife to areas where they formerly existed, or to new areas where they may flourish. Transplants, however, are expensive and not always successful. The following factors must be considered:

1) Habitat or range studies should take place before transplants occur, to ensure that forage requirements are suitable for introduced animals.

2) The act of transferring animals must be carefully undertaken to prevent death or undue stress during transit.

3) Finally, it is seldom economically feasible to introduce a sufficient number of animals into a new area to absolutely guarantee their survival. It is not unusual for introduced animals to attempt to leave the area they have been taken to.

Wildlife transplants in the N.W.T. have occurred as follows:

Wildlife	Year	Origin	Destination
Reindeer	1935	Alaska	Inuvik/Tuk area
Wood bison	1963	Wood Buffalo Nat'l Park	Mackenzie Bison Sanctuary
Caribou	1967	Coates Island	Southampton Island
Reindeer	1978	Inuvik/Tuk area	Belcher Islands
Wood bison	1980	Elk Island Nat'l Park	Nahanni Butte

Bibliography

Dasmann, Raymond F. 1964. Wildlife Biology. John Wiley & Sons. 231 pp.

Schemnitz, Sanford D., ed. 1980. Wildlife Management Techniques Manual. The Wildlife Society. 686 pp.

Smith, Robert Leo. 1974. Ecology and Field Biology. Harper & Row. 850 pp.

Teague, Richard D. and Eugene Decker, eds. 1979. Wildlife Conservation: Principles and Practices. The Wildlife Society. 280 pp.

LAWS AND JURISDICTIONS

Since wildlife is a shared resource, laws are requird for the good of everyone to prevent misuse by a few. There are two types of legislation which implement management strategies to control the use and conservation of wildlife:

> Acts or Ordinances - These establish the authority under which the legislating body operates, and outline the general rules which must be abided by. They are passed following discussion and assent by elected representatives in the House of Commons (for federal statutes), or in Legislative Assemblies (for provincial or territorial statutes).
>
> Regulations - An Act or Ordinance may authorize the passing of certain additional laws without the need for further assent by elected representatives. These are called Regulations and are approved in principle by the appropriate Act or Ordinance. They spell out specific details, as required.

For instance, a standard procedure is for the enabling legislation (Act or Ordinance) to state that seasons and bag limits will be set. The exact details are then given in the Regulations. Items such as these are often adjusted from year to year, and can be handled more quickly and effectively in this manner.

In the N.W.T. there are three sets of legislation affecting wildlife.

Migratory Birds

The mandate to manage migratory birds rests primarily with the federal government. The enabling legislation is the Migratory Birds Convention Act (MBCA), which applies an international treaty between Canada and the United States passed in 1916. This Act takes precedence over all provincial and territorial legislation, and establishes general laws regarding the utilization of migratory game birds, migratory insectivorous birds, and migratory nongame birds. As defined in the MBCA, migratory game birds are:

a) Anatidae or waterfowl, including brant, wild ducks, geese and swans;

b) Gruidae or cranes, including little brown, sandhill and whooping cranes;

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c) Rallidae or rails, including coots, gallinules, and sora and other rails;

d) Limicolae or shorebirds, including avocets, curlew, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock and yellowlegs;

e) Columbidae or pigeons, including doves and wild pigeons.

Migratory insectivorous birds are:

bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, hummingbirds, kinglets, martins, meadowlarks, nighthawks or bull bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whippoorwills, woodpeckers, wrens, and all other perching birds which feed entirely or chiefly on insects.

Migratory nongame birds are:

auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters and terns.

The Migratory Birds Regulations set specific laws regarding such things as seasons, possession limits, permits, equipment, etc.

The need for a co-ordinated approach is evident when it is realized that migratory birds cross territorial, provincial and international boundaries every year. Unilaternal action by provinces or states could result in serious depletion of numbers.

The agency charged with the responsibility for administering the MBCA and Regulations is the Canadian Wildlife Service, a federal agency. RCMP Officers and N.W.T. Wildlife Officers have ex officio appointments to enforce these laws

For further information, see the following publications:

Office Consolidation of the Migratory Birds Convention Act and the Migratory Birds Regulations.

Birds Protected in Canada under the Migratory Birds Convention Act. Canadian Wildlife Service Occasional Paper No. 1.

Fish & Marine Mammals

The mandate to manage fish and marine mammals in the N.W.T. also rests with the federal government. The enabling legislation is the Fisheries Act. Subsidiary legislation includes:

N.W.T. Fishery Regulations
Narwhal Protection Regulations
Walrus Protection Regulations
Beluga Protection Regulations
Seal Protection Regulations

These laws govern commercial, domestic and sport fishing in the N.W.T. and the use of marine mammals.

The agency charged with the responsibility of administering these laws is the federal Department of Fisheries & Oceans. Fisheries Officers enforce these laws, as do RCMP Officers and N.W.T. Wildlife Officers, who have ex officio appointments.

Note: The N.W.T. Wildlife Service issues angling licences. An annual Sport Fishing Guide is available free from any vendor or Wildife Office.

Terrestian Mammals & Non-Migratory Birds

The mandate to manage terrestrial mammals, as well as a few species of birds, rests with the Territorial Government. The enabling legislation is the N.W.T. Wildlife Ordinance and the subsidiary legislation is the N.W.T. Wildlife Regulations. The agency which adminsters these laws is the N.W.T. Wildlife Service. Laws are enforced by N.W.T. Wildlife Officers, and also by RCMP Officers and Fisheries Officers, who have ex officio appointments.

Wildlife managed under the authority of the N.W.T. Wildlife Ordinance include the following:

i) big game - bison, coyote, wolf, mountain lion, wolverine, mountain goat, mountain sheep, muskox, bears, deer, moose, caribou;

ii) birds of prey - eagles, falcons, hawks, osprey, owls;

iii) fur-bearing animals - beaver, white fox, coloured fox, otter, lynx, marten, fisher, skunk, ermine weasels, mink, muskrat, squirrels, wolverine, wolf, coyote;

iv) small game - porcupine, hare, marmots. woodchuck, ground hogs, squirrels, upland game birds, (grouse and ptarmigans);

v) nongame birds - crows, jays, ravens, blackbirds, orioles, pelicans, kingfishers, and birds that are not upland game birds or migratory game birds but that in their natural habitat are found wild in nature and naturally occurring in the N.W.T.;

vi) nongame animals - wood rat, chipmunks, bats, flying squirrels.

a) Public Involvement in Wildlife Management

The N.W.T. is currently working towards the building of a comprehensive system of public participation in wildlife management. Input will be received at both community and regional levels, and co-ordinated on a Territorial basis by a wildlife management board. Similar organizations already exist -- at the regional level there are two, the Baffin Regional Hunters and Trappers Association, and the Keewatin Wildlife Federation. At the Territorial level is the Game Advisory Council, which is now virtually defunct, but which previously played an important role during the formation of the present N.W.T. Wildlife Ordinance (which came into effect in 1979).

Another example of public participation in wildlife matters is the Beverly/Kaminuriak Barren-Ground Caribou Management Board formed 1981. The Board is composed of 13 members, of which 8 will be appointed by traditional users and 5 by government.

b) Hunters and Trappers Associations

Hunters and Trappers Associations (HTA's) are officially recognized in the N.W.T. Wildlife Ordinance. They are defined as a "Hunters and Trappers Association, or, if there is no such Association, the council of a band, within the meaning of the Indian Act, or another local organization, recognized by the Superintendent to represent the normal hunting area in which the relevant activity is or is to be conducted." Their powers are as follows:

i) They may recommend for or against:
- the issue of a special General Hunting Licence
- the renewal of a special General Hunting Licence
- the issue of a permit to conduct courses where wildlife is hunted
- the issue of a wildlife research permit
- the issue of a special trapping licence
- the issue of a licence to capture live wildlife
- the issue of or amendment to a registered trapping area licence

Northwest Territories

WILDLIFE SERVICE

№ 9613

RECOMMENDATION FORM

[HUNTERS AND TRAPPERS ASSOCIATION]

SUBJECT TO THE PROVISIONS OF THE WILDLIFE ORDINANCE AND REGULATIONS THE

________________________ HUNTERS AND TRAPPERS ASSOCIATION

☐ SUPPORTS
☐ DOES NOT SUPPORT

THE APPLICATION OF ________________________
(NAME OF APPLICANT/GROUP)

FOR THE FOLLOWING LICENCE/PERMIT

	CHECK ONE
1 ISSUE OF "GENERAL HUNTING LICENCE" UNDER SECTION 17(1)C OF THE WILDLIFE ORDINANCE	☐
2 RENEWAL OF GENERAL HUNTING LICENCE # ____________ UNDER SECTION 17(1)C OF THE ORDINANCE	☐
3 *ISSUE OF "PERMIT TO CONDUCT COURSES WHERE WILDLIFE IS HUNTED" UNDER SECTION 19(1) OF THE WILDLIFE ORDINANCE	☐
4 ISSUE OF "WILDLIFE RESEARCH PERMIT" UNDER SECTION 13(3) OF THE WILDLIFE REGULATIONS	☐
5 *ISSUE OF "SPECIAL TRAPPING LICENCE" UNDER SECTION 17(2) OF THE WILDLIFE REGULATIONS	☐
6 ISSUE OF "LICENCE TO CAPTURE LIVE WILDLIFE" UNDER SECTION 18 OF THE WILDLIFE REGULATIONS	☐
7 ISSUE OF OR AMENDMENT TO "REGISTERED TRAPPING AREA LICENCE" UNDER SECTION 36(2) OF THE WILDLIFE REGULATIONS	☐
8 ISSUE OF OR AMENDMENT TO "REGISTERED GROUP TRAPPING AREA LICENCE" UNDER SECTION 37(2) OF THE WILDLIFE REGULATIONS	☐

*RECOMMENDED TERMS AND CONDITIONS

____
SIGNATURE OF H.T.A. PRESIDENT

DATE ______ / ______ / ______
DAY MO YR

NWT 1606-15/0581

1 WHITE - WITH ORIGINAL OF APPLICABLE APPLICATION 2 WHITE - WITH FIRST COPY OF APPLICABLE APPLICATION
3 WHITE - WITH SECOND COPY OF APPLICABLE APPLICATION

- the issue of or amendment to a registered group trapping area licence

Input on any of the above items is routinely requested by the Wildlife Service before any action is taken, and recorded on a special form.

ii) In areas where there are muskox and polar bear quotas, the tags are given to HTA's for distribution to their members as they see fit. Commercial tags (covering the sale of meat from muskox, polar bear and caribou) are also issued to HTA's, where applicable.

iii) Only registered HTA's may act as outfitters for polar bear and muskox sport hunts.

iv) Hides from defence-killed bears are turned over to regional HTA's for disposal.

In addition, the N.W.T. Wildife Service has a policy of consulting regularly with HTA's on all wildlife management matters. Regional conferences are organized annually and funded by the Wildlife Service. An annual operating grant of $2000 is paid to each local HTA by the Wildlife Service.

c) Wildlife Guardians

The Wildlife Ordinance allows for the appointment of wildlife guardians upon the recommendation of a Hunters and Trappers Association, band council, or recognized sportman's organization. The main duty of a wildlife guardian is to maintain open communications between the sponsoring organization and the Wildlife Services. He also reports violations, but is assigned enforcement powers only upon completion of an enforcement course, and with the concurrence of the sponsoring organization. Each wildlife guardian must take an oath of office. He is issued a badge of office and paid an annual honorarium.

The following information items are available to the public:

N.W.T. Wildlife Ordinance	cost $1.00 Department of Information
Summary of Sport Hunting Regulations †	free from Wildlife Service
Summary of Trapping Regulations †	
N.W.T. Wildlife Ordinance (simplified English)†	
N.W.T. Wildlife Ordinance (syllabics) †	
N.W.T. Wildlife Ordinance (Slavey) †	

CAREERS

The Renewable Resources Technology Program run by Thebacha College at Fort Smith provides the training necessary to work not only as a Wildlife Officer, but also as a technician in the area of land use, forestry, fire control, surveying, water resources, fisheries, wildlife and parks.

The program offers a balance of classroom instruction, laboratory study and field experience over a period of four semesters. Four 4-week field camps are included in the program. Those students not requiring the academic upgrading and introductory courses begin the program in August with the introductory field camp.

a) Introductory Semester

Students who wish to enroll in the Renewable Resources Technology Program but do not possess the entrance requirements, may apply for admission into the R.R.T.P. Introductory Semester. To enter the Introductory Semester, the candidate must score ten on the T.A.B.E. test in both mathematics and English.

The objective of the Introductory Semester is to develop the students' skills in mathematics, English and biology to the point where he/she may proceed with the regular Renewable Resources Technology Program.

b) 1st Semester (September to December)

- introductory field camp at Tsu Lake near Fort Smith
- written communications
- drafting and mapping
- forest and range botany
- fire science 1
- geology and soils
- first aid and survival training
- mathematics review
- general forestry

c) 2nd Semester (January to April)

- oral communications
- photogrammetry and mapping
- wildlife biology
- ecology

- parks: introduction
- fire science 2
- mathematics review
- resource economics and geography
- winter camp

d) 3rd Semester (August to December)

- a 4-week Arctic Marine camp in August
- mathematics: applied statistics
- wildlife techniques
- water resources management
- parks: planning and design
- surveying
- environmental law
- marine fisheries: biology and management
- special project
- oil spill response
- small motors

e) 4th Semester (January to April)

- wildlife management
- parks: operation, maintenance and administration
- administration and supervision
- law enforcement
- freshwater fisheries: biology and management
- forest mensuration
- anthropology
- technical project
- environmental policy and planning
- field practicum at various locations in the Yukon

Applicants wishing to enroll in the Renewable Resources Technology Program should be at least 17 years of age and have a grade 12 graduation diploma. Preference is given to students with the following credits: math 30 or 33, biology 30, English 33, chemistry 20 and physics 10. Mature students with a GED grade 12 certificate may also apply to the program. Applicants not meeting these requirements will be considered for the Introductory Semester of the program. Upon successful completion of Introductory Semester, the student may apply to continue with the remainder of the program.

All applicants should have demonstrated a keen interest in the outdoors, be in good physical condition, and be able to pass a medical examination prior to final acceptance.

Persons interested in applying for this program should contact their high school counsellor, local adult educator, settlement secretary, education office, or Canada Employment Centre.

Application forms and further information on financial assistance, accommodation and other student services are available from the above or by contacting:

The Registrar
Thebacha College
P.O. Box 600
Fort Smith, N.W.T.
XOE OPO

3. CHEMISTRY IN OUR DAILY LIVES (15 HOURS)

OBJECTIVES

After completing this unit students will be able to:

1. Recognize when a chemical reaction has taken place.
2. Recognize the difference between a physical and a chemical change.
3. Identify the uses and hazards of common household substances such as: acids and bases, soaps, and natural and artificial fibres.
4. Discuss the basic atomic theory, including the Bohr concept of the atomic structure which includes the neutrons, protons and electrons.
5. Experience, through experimentation, the application of chemical techniques in our daily lives.
6. Use basic laboratory techniques.
7. Keep accurate records of observed events.

CAUTION: Tasting, smelling and touching of substances (chemicals) only upon the specific direction of the teacher.

A series of articles and information packages has been included in this guide for use.

The first article deals with Kitchen Chemistry.

One approach: It outlines a basic kitchen chemistry exercise and related activities as well as enrichment projects.

The section on basic atomic theory can be covered by referring to any basic physical science or chemistry text. There is no need to go into great detail on atomic theory - just a basic explanation of what an atom is, types of bonding and the difference between an atom and an ion are required.

Physical and Chemical changes is another topic which need not be covered in great detail. The students should already be familiar with the two concepts from previous studies. Any physical science or introductory chemical text will provide ample examples of these two concepts for your use. A classic example of a chemical change is the production of ice cream in a test tube. This exercise has been included in this guide for your use.

Solutions is another topic in this unit. A sample work unit on solubility curves and problems is included in this guide.

Students need to understand the concepts of saturated, unsaturated, supersaturated, solute, solvent and solution before proceeding with the sample work unit. Also enclosed is an experiment on a supersaturated solution using sodium thiosulphate.

The last topic in this unit deals with the applications of chemical techniques. A list of several experiments are included for teacher selection. Teachers should spend about ten periods on this section.

KITCHEN CHEMISTRY - ONE APPROACH

PROCEDURE:

Take six test tubes and put the following solutions in them:

1. Lemon Juice
2. Water
3. Vinegar
4. Palmolive Dish Soap
5. Cream rinse
6. Windex

Each of these solutions can be found in any kitchen. Have the students identify the various household liquids, using the senses of smell, touch and sight. Caution the students not to taste any of the solutions.

An indicator can be used to see how each solution will react. For an indicator, use purple cabbage juice. If the solution turns green or yellow, the mixture is basic; if the solution turns red or pink. it's acidic. If the solution turns purple it is neutral.

The experiment begins with an explanation by the instructor. The students, in small groups or at separate tables, then do the experiment themselves, following step by step directions. The teacher can adjust the complexity of the experiments to the level of each class. The final phase of the experiments includes:

1. The reaction of each of the liquids with purple cabbage juice.

2. The classification of the liquids as acidic, basic or neutral, according to the results of these experiments.

The pH scale is explained and the properties of acids and bases are discussed as a conclusion to this exercise.

OTHER RELATED ACTIVITIES

1. Using cabbage juice as an indicator, test the pH level of various shampoos. If you get litmus paper, test to see if it is a more sensitive indicator to pH than cabbage juice.

2. Test other household liquids for pH. You can also test solids after dissolving them in water.

3. Build a crystal garden. Place one or two charcoal briquettes in a glass or jar and cover with a solution of 1/2 cup water and 1/2 cup salt. Crystals will appear on the briquettes in one or two days. You can add food coloring to obtain different colored crystals. You can also grow crystals from solutions of sugar, boric acid, alum or copper sulphate.

4. Dissolve "Kool-Aid" powder and compare how quickly it dissolves in hot and cold water and in a stirred or unstirred liquid.

5. Find out how soap cleans. Add light household oil to about 15 ml of water in a large test tube. When you have a layer of oil on the water, shake the tube. The oil and water will separate again after you stop.

   Now add 5 ml of soap solution and shake again. This time the oil layer doesn't reappear, because the soap has broken the oil up into tiny droplets which remain suspended in the water.

ENRICHMENT PROJECTS RE HOUSEHOLD SOLUTIONS

1. Survey advertisements for household cleaners to see if any scientific facts are stated and make a bulletin board display of your findings.

2. Collect labels from bleach, detergent, household cleaners, etc. and note the contents, mixing instructions and warnings listed on each label.

3. Bring in containers of relatively dangerous household chemicals (bleach, drain cleaner, aspirin, etc.) and see if they are child proof. If they aren't, members of the class could write to the companies involved.

4. Make a mixture of 10 ml cabbage juice. Prepare a solution of base (1 gram baking soda, 20 ml water). Mix the soda solution with 10 ml cabbage juice. What color is each mixture? What happens if we combine both mixtures? What happens if we add one mixture to the other mixture drop by drop?

PURPOSE: TO PREPARE A SUPERSATURATED SOLUTION

PROCEDURE AND APPARATUS:

1. Put crystals of sodium thiosulphate to a depty of 2.5 cm in a clean, dry test tube. Add 10 drops of water. Place thumb over the end of the end of the tube and shake it for one minute. Note any temperature change by placing the test tube against the back of your hand. Examine the contents.

2. Put crystals of sodium thiosulphate to a depth of 10 cm in a clean, dry test tube. Add 10 drops of water, and gently warm the tube (without agitation) until all the crystals are in solution. Place some absorbent cotton in the mouth of the test tube, and hold the tube in a stream of cold water from the tap until it is cooled to approximately its initial temperature.

QUESTIONS

1. At what stage during this procedure is the solution saturated?
____

2. Give a reason for your answer. ______________________
____
____

3. Is the hot solution saturated before cooling? ______________

4. How could you have tested it to find out? ______________
____
____

5. Hold the test tube that contains the supersaturated solution so that it may be viewed against a light background. Add a small crystal of sodium thiosulphate and observe. Note any temperature change.

6. What happened when the sodium thiosulphate crystal was added?
____
____

7. What kind of solution remained? ______________________
____

OBSERVATIONS

Sodium Thiosulphate Description.

SOLUTIONS WORK UNIT
SOLUBILITY CURVES AND PROBLEMS

On a single piece of graph paper, plot solubility curves for each substance. Label each curve, be sure your graph is of good form.

	SOLUBILITY (g/100 cm^3 of water)						
TEMPERATURE (°C)	SODIUM CHLORIDE	POTASSIUM SULFATE	MERCURIC CHLORIDE	POTASSIUM NITRATE	SODIUM NITRATE	COPPER SULFATE	SUGAR
0	35	8	4	12	70	15	180
20	36	12	6	32	85	21	205
30	36	14	8	46	95	25	220
40	36	15	10	62	103	28	240
50	37	17	12	85	113	32	260
60	37	18	15	110	123	40	290
75	38	20	20	155	140	52	355
90	39	23	37	205	162	65	
100	40	25	48	240	180	75	

QUESTIONS

Answer in the spaces provided; be sure all measurements have units; be as accurate as possible.

1. What changes take place in the solubility as temperature gets higher? ______________________________

2. Which substance is least soluble at 0°C? ______________

3. Which substance is most soluble at 0°C? ______________

4. Which substance is least soluble at 100°C? ______________

5. Which substance is most soluble at 100°C? ______________

6. Which substance has the least change in solubility between 0°C and 100°C? ______________________________

7. Which substance has the most change in solubility between 0°C and 100°C? ______________________________

8. What is the solubility of sodium chloride at 25°C? ______________

9. What is the solubility of potassium sulfate at 10°C? ______________

10. What is the solubility of mercuric chloride at 45°C? ______________

11. What is the solubility of potassium nitrate at 70°C? ______________

12. What is the solubility of sodium nitrate at 10°C? ______________

13. What is the solubility of copper sulfate at 80°C? ______________

14. What is the solubility of sugar at 45°C? ______________________

15. Which substance has a solubility of 100 g/100cm^3 at 36°C?
    ____

16. Which substance has a solubility of 50 g/100cm^3 at 33°C?
    ____

17. Which substance has a solubility of 200 g/100cm^3 at 17°C?
    ____

18. Which substance has a solubility of 150 g/100cm^3 at 83°C?
    ____

19. Which substance has a solubility of 10 g/100cm^3 at 16°C?
    ____

20. Which substance has a solubility of 50 g/100cm^3 at 73°C?

21. At what temperature does sugar have a solubility of 300 g/100cm^3?
    ____

22. At what temperature does potassium nitrate have a solubility of 100 g/100cm^3? ____________________

23. At what temperature does sodium nitrate have a solubility of 90 g/100cm^3? ____________________

24. At what temperature does copper sulfate have a solubility of 57 g/100cm^3? ____________________

25. At what temperature does mercuric chloride have a solubility of 30 g/100cm^3? ____________________

26. At what temperature do potassium nitrate and sodium nitrate have the same solubility? ________________
What is the solubility? ________________

27. At what temperature do sodium chloride and copper sulfate have the same solubility? ________________
What is the solubility? ________________

28. At what temperature do potassium nitrate and sodium chloride have the same solubility? ________________
What is the solubility? ________________

29. At what temperature do mercuric chloride and sodium chloride have the same solubility? ________________
What is the solubility? ________________

30. At what temperature od potassium sulfate and mercuric chloride have the same solubility? ________________
What is the solubility? ________________

31. How much sugar will dissolve in 50cm^3 of water at 30°C? ____________

32. How much sodium chloride will dissolve in 50cm^3 of water at 100°C? ________________

33. How much potassium sulfate will dissolve in 50cm^3 of water at 75°C? ________________

34. How much copper sulfate will dissolve in 200cm^3 of water at 0°C? ________________

35. How much mercuric chloride will dissolve in 200cm^3 of water at 40°C? ________________

36. How much sodium nitrate will dissolve in 400cm^3 of water at 50°C? ________________

37. How much potassium nitrate will dissolve in 10cm^3 of water at 60°C? ________________

38. How much copper sulfate will dissolve in 25cm^3 of water at 60°C? ________________

39. A person puts 20g of potassium sulfate into 100cm^3 of water at 20°C. (a) How much will dissolve? ______________ (b) How much is on the bottom? ______________ (c) Classify the solution: ______________ (d) If the water is heated, at what temperature will all 20g dissolve? ______________

40. A person puts 20g of sodium chloride into 100cm^3 of water at 20°C. (a) Will all the chemical dissolve? ______________
(b) Classify the solution: ______________ (c) How much more chemical could be added and dissolve? ______________

41. A person has a saturated solution of mercuric chloride at 90°C. (a) How much chemical is dissolved? ______________ (b) The solution is cooled to 40°C, how much chemical will remain dissolved? ______________ (c) How much chemical will there be on the bottom at 40°C? ______________ (d) The same solution is cooled to 0°C, how much chemical (in total) is there on the bottom? ______________

42. A person has a saturated solution of sodium chloride in 100cm³ of water at 100°C. (a) How much chemical is dissolved? ______________ (b) The person boils the water away so that only 50cm³ remain. How much chemical will there be on the bottom (at 100°C)? ______________ (c) The boiling continues until only 25cm³ of water remain. How much chemical will there be on the bottom (at 100°C)? ______________

43. Suppose 240g of sugar are added to 100cm³ of water at 0°C. (a) Will all the sugar dissolve? ______________ (b) How much will there be on the bottom? ______________ (c) The solution is heated to 20°C, how much sugar is there on the bottom? ______________ (d) At what temperature will all (240g) of the sugar dissolve? ______________ (e) If the temperature of the solution is raised to 75°C, how much more sugar could be added and still dissolved? ______________

44. If 300g of sugar are added to 100cm³ of water at 50°C, describe what would be seen in the test tube. ______________

45. Suppose a saturated solution of potassium nitrate at 100°C is cooled to 50°C. Describe (completely) the appearance and characteristics of the solution after the cooling. ______________

46. 100g of potassium nitrate are put in 100cm³ of water at 80°C. The solution is then cooled to 10°C. How much precipitate will there be on the bottom? (Show Work) ______________

47. A person has 200cm³ of a saturated solution of potassium nitrate at 75°C. The solution is then cooled to 30°C. How much precipitate will there be on the bottom? (Show Work) ______________

48. A person adds 100g of copper sulfate to 200cm³ of boiling water. The solution is then cooled to 20°C. How much precipitate will there be on the bottom? (Show Work) ______________

49. A person adds 10g of sodium nitrate to 10cm³ of water at 80°C. As the solution is cooled, at what temperature should a precipitate first appear? (Show Work) ______________

50. A mass of 100g of potassium nitrate is dissolved in 100cm^3 of water at 100°C. As the water is boiled away, at about what volume will a precipitate first appear? ____________________________

____

51. At what temperature is potassium nitrate twice as soluble as sodium nitrate? ____________

52. At what temperature is sodium chloride twice as soluble as copper sulfate? ____________

53. At what temperature is copper sulfate twice as soluble as mercuric chloride? ____________

54. At what temperature is potassium sulfate twice as soluble as mercuric chloride? ____________

APPLICATION OF CHEMICAL TECHNIQUES

From this list, teachers should choose as many experiments as allowed by time constraints. Three reference books have been used:

1) Bolton, R.P. et al.,

Action Chemistry

Holt, Rinehart and Winston, Incorporated
55 Horner Avenue
Toronto, Ontario
M8Z 4X6

2. Kowalski, S.W.

Consumer Science - Text and Laboratory Manual

Kendall/Hunt Publishing Co.
2460 Kerper Blvd.
Dubuque, Iowa U.S.A. 52001

3. Pryde, Lucy T.

Environmental Chemistry

Cummings Publishing Co.
Weston Walsh
Portland, Main
04104

LABORATORY EXERCISE	REFERENCE
1. Rating different brands of toothpaste. Students rate toothpaste according to Abrasiveness, smell and color appeal. Review meaning of pH.	Consumer Science pp. 100-103
2. Rating shampoos. Students rate color, odor and consistency. Review concept of pH.	Consumer Science p. 115
3. Antacids. A prelab will have to be done to explain stomach acidity and neutralization. Also a demonstration of titration.	Consumer Sicence p. 122
4. Lubricating oils. Discusses the terms viscosity, S.A.E. ratings, and pour points for oils.	Consumer Science pp. 41-45
5. Components of coffee. Discuss the handling of chloroform and demonstrate decanting and the use of separatory funnel.	Consumer Science
6. Headache preparation. Teacher may wish to assign each group a different headache preparation to test in order to save time.	Consumer Science pp. 119-121
7. Natural and Synthetic Fibres. Identification of chemical elements in fibres.	Action Chemistry pp. 9/14 - 9/19
8. Making Cold Cream. Review use of balance. Discuss the meaning of emulsifying agent, immiscible liquids.	Action Chemistry pp. 7/26-7/32
9. Making lipstick. Ensure availability of spermaceti and beeswax.	Action Chemistry pp. 7/26-7/32

10.	Determination of vitamin C. Discuss the source and function of vitamin C. Demonstrate the titration procedure. Explain the formula used to calculate the amount of vitamin C present in samples.	Consumer Science pp. 151-164
11.	Effects of cigarettes on living animals. Demonstrate and explain the behaviour of planaria.	Consumer Science pp. 142-146
12.	Food components. Discuss fats, carbohydrates, and proteins found in various foods.	Consumer Science pp. 151 164 Action Chemistry pp. 6/20-6/29
13.	The action of soaps. Discuss how soaping action cleans.	See Kitchen Chemistry notes
14.	By it's smell- Preparation of Esters. Making common odours found in any kitchen.	Included with above mentioned labs
15.	Preparation of ice cream in a test tube. Demonstrate a chemical change.	Included with above mentioned labs

All of the above experiments can be found in this guide, immediately following the acknowledgements listed below.

The Dept. of Education would like to gratefully acknowledge Holt, Rinehart and Winston of Canada Ltd. for permission to include the following experiments from the publication " Action Chemistry- Bolton, R.P. et al".

1. Natural and Synthetic Fibres pp. 9/14-9/19
2. Making cold cream pp. 7/26-7/32
3. Making lipstick pp. 7/26- 7/32
4. Food components pp. 6/20-6/29

The Dept. of Education also acknowledges Kendall/Hunt Publishing Company for permission to use extracts from the following book- "Consumer Science- Kavalski S.W."

1. Rating different shampoos pp 115
2. Rating brands of toothpaste pp. 1oo-1o3
3. Antacids pp. 122
4. Lubricating Oils pp. 41-45

5. The components of coffee pp. 130-131
6. Determination of vitamin C. pp. 151-164
7. Food components pp. 151-164
8. Effects of cigarettes on living animals pp. 142-146
9. Headache preparation pp. 119-121

The Dept. of Education would also like to acknowledge the Edmonton Separate School Board for permission to use extracts from a publication entitled " Chemistry For Science 11 "

Lab: "RATING DIFFERENT BRANDS OF TOOTHPASTE"

"Makes your teeth kissing fresh," "guards against cavities," "gives your mouth sex appeal," "__percent less cavities." These ads run the gamit from sex to health. How do we decide how to buy a toothpaste?

How does a toothpaste clean one's teeth? Is it a bleach, an abrasive, or some other brightener? Yet what most people don't realize is that most teeth are anything but white. Approximately ninety percent of the population of the world have teeth which are off-white, cream colored, yellow or some darker shade. These are natural colors and are not necessarily due to staining from smoking or the like. Frequent brushing with a good toothpaste that will clean but not wear away the tooth, will keep not only the teeth cleaner and brighter but also a fresher mouth and a psychological, if nothing more, feeling of acceptability. Whenever toothpaste is used there is some degree of abrasion therefore the proper brushing technque is most important. The teeth should always be brushed from the gums downward or upward as the case may be to follow the natural grain of the tooth itself. Brushing across or in any other than the right way will eventually wear away the tooth, therefore, the degree of abrasion contained in the toothpaste is extremely important. The mouth is normally slightly acidic to aid in the digestive process, therefore, the toothpaste used should not vary too much from a pH of approximately six to seven. The color, odor, taste, and feel are the prime factors for which most people usually buy.

APPARATUS AND MATERIALS:

- toothpaste
- microscope slides
- pH paper
- distilled water
- colored cloth or paper
- test tubes
- 25 mL graduates
- spatulas
- pH paper

from Consumer Science

Lab: RATING DIFFERENT BRANDS OF TOOTHPASTE" (cont.)

Procedure

A. Squeeze out about an inch of each paste on a white background. Record each color, odor, taste. Rate each category as pleasant, acceptable, unpleasant. Take a small amount of each and rub it between the fingers to get the feel of it. Rub a small amount of each on the inside smooth, tender part of the arm. (be sure to mark each brand) Record your sensation to each as to degree of coarseness, one (1) being the least coarse. After about 15 minutes wash off the samples and determine if there is any irritation caused.

Brand	Color	Rating	Odor	Rating	Taste	Rating	Coarseness	Irritations

B. Take a small portion or small spot of each sample above and place it between two glass slides. Rub the slides slowly upon each other and note the degree of abrasiveness by the extent of scratching noted on the glass after the toothpaste is washed off. Record and rate each.

Brand	Abrasiveness	Bleaching	pH	pH of Your Mouth	Recommended For You

Procedure (cont.)

C. Place a length of about 3 mm of each sample on a colored piece of cloth (or colored poster paper) which was prewet. Flatten each piece upon the material and after 15 minutes remove the paste by washing under the tap and determine if there is any fading of color. The more fading the greater the bleaching effect.

D. While the bleaching test is in progress above, take a small piece of pH paper, wet it with distilled water and place it upon each sample for approximately one minute. Determine the pH of each sample. Place a small piece of pH paper on your tongue for just a few moments to determine the pH of your mouth. Compare your pH with that of the toothpaste.

E. Place exactly 3 cm of each sample in 10 mL of distilled water in a test tube. Shake vigorously for a few minutes to dissolve the sample. Observe any sudsing or foaming action. Allow the solution to settle and determine:

1) any color transmitted to the water
2) cloudiness or turbidity
3) the amount of insoluble residue and color if any
4) pH of the solution. Extract the residue and compare the grittiness of each.

F. Determine how much each sample has dried out since squeezed from the tube.

Lab : Rating Different Kinds of Toothpaste

G. Record the price of each sample and the quantity of sample in each tube. Use all the data to come up with a final rating.

Brand	Foaming Action	Color	Turbidity	Amount Residue	pH of Solution	Degree of Residue Grit	Drying Effect	Quantity in Tube	Price	Final Rating

Shampoo (Lab)

Calibrate a dropper to determine how many drops make one milliliter.

A. 1. Determine the pH of each shampoo.

2. Wet piece of pH paper and place upon the scalp preferably in contact with much hair. Record your pH. Indicate when hair was last washed.

3. Rate color, odor, consistency as pleasant, acceptable, or unsatisfactory.

B. 1. Clean a 100 mL Erlenmeyer flask and rinse with distilled water.

Using 50 mL of distilled water for each sample, add one drop of each shampoo to prepare the testing sample.

2. Using one of the test samples above, add one drop at a time of each shampoo solution, to 50 mL of distilled water, shake, and determine how much shampoo is needed to produce an unbroken film of suds at the surface.

C. 1. Dip a glass slide into each shampoo sample. Allow to drip off and dry. Observe any residue left upon the glass. Using another glass slide dip again then dip into a beaker of distilled water to see if it can be easily rinsed off. Allow to dry and determine amount of residue on each slide.

D. 1. Using the rest of the prepared shampoo solutions, pour about 10 mL of each into a watch glass or petri dish. Add one drop of the dirty oil sample to each shampoo and observe what happens. Determine and rate the oil cutting characteristics. Compare the shampoo for normal hair to that for dry, to the shampoo for oily hair.

E. 1. Read the labels to determine what claims are made. Compare the price of the claims. See chart on following page.

From: Consumer Science

SHAMPOO (LAB)

Shampoo	mL to Make Suds	pH of Sample	pH of Hair	Color	Odor	Consis-tency	Oil Dispersion	Residue	Residue After Rinse	For Normal, Oily or Dry	Claims	Amount	Price	Rating

Lab: "Antacids (LAB)"

Every person has at one time or another eaten too much, drunk too much or in some way or other upset his stomach. One of the most common stomach ailments is over acidity. Though if the opposite situation were to occur the stomach would be just as upset. The normal pH of the stomach is about four, slightly on the acid side. The pH is usually maintained by buffers secreted in the stomach as needed to handle slight excess conditions. When one takes an "antacid" the intent is to reduce acidity but not to overdo it. It is well therefore to have each antacid buffered as well. Many antacids are simply alkalizers and if a condition of alkalosis of the stomach exists it can be extremely dangerous from a chemical standpoint to take that antacid. The buffering action controls the excess acidity or alkalinity.

Procedure:

A. *Solubility:* Dissolve each sample of antacid in 150 ml of distilled water. If necessary, shake vigorously to dissolve and note any color, turbidity, or undissolved residue. Determine how quickly each dissolves.

B. *pH:* Determine the pH of each solution above (Chart below for results).

C. *Amount of acid neutralizing effect:* Divide each sample exactly in half.

   1. Add two drops of phenolphthalein to one half and titrate with 0.1 mol/m^3 sodium hydroxide solution until a faint pink color appears. The more sodium hydroxide used the more the antalkalizing effect. Record the amount.

   2. To the other half add two drops of cresol purple and titrate with 0.1 mol/m^3 hydrochloric acid until a yellow color develops. The more hydrochloric acid needed the more the antacid effect. Record the amount.

   3. If the solution is buffered it will take a large amount of sodium hydroxide as well as a large amount of hydrochloric acid. If either is only a small quantity the solution is not buffered. If that occurs determine what condition the product is helpful for. (Chart for this on next page).

from Consumer Service

Lab: "Antacids (LAB)" (cont.)

Brand	Speed of Dissolving	Color in Solution	Turbidity	Residue	pH

Titration Chart

Brand	mL of NaOH	mL of HCL	Buffered	Comments

D. *Fizzing action:* Any of the products above that fizzed when put into water may be tested here. Take each of these samples and test the pH by placing a wet piece of pH paper on the sample (be sure to shake off any excess water before putting the paper on the tablet). Determine the amount and time of fizzing of these samples by placing one tablet in 150 mL of distilled water. Test the pH while the fizzing takes place and after the fizzing stops. Place a teaspoonful of baking soda into 150 mL of water. Determine the pH before, during, and after fizzing stops. Relate the time of fizzing and type of fizzing to the other products.

E. Rate the products tested with a consideration also to price and quantity.

Lab: "Antacid (LAB)" (cont.)

Fizzing Brand	pH Before	pH During Fizzing	pH After	Time of Fizzing

Lab: "Lubricating Oils"

Lubricating oils are sold according to grades determined by their viscosity. (Viscosity is the resistance to flow or rate of flow.) Rate of flow varies with temperature, the higher the temperature the more rapid the flow, therefore, to determine viscosity it is necessary to test and grade the oils at some standard temperature. The lighter oils are tested at 55°C and the heavier oils at about 99°C. The viscosity is determined by the time (in seconds) required for a sample to flow through a viscometer.

Commercial oil contains an "S.A.E. rating" given by Society of Automobile Engineers, the higher number being the more viscous.

The S.A.E. rating is the usual reference for determination of which oil to buy at a certain time of the year dependent upon temperature. The lower the S.A.E. the more likely it it used in winter; the higher the S.A.E. the more likely the oil is a summer oil. Today multipurpose oil may be listed as 10-30. What might this imply?

Materials:

- 200 mL beaker
- 400 mL beaker
- Bunsen burner
- ring stand
- wire gauze
- 25 mL graduate
- 10 mL pipette - preferably disposable type (these may be made by the students by drawing out a piece of glass tubing)
- lubricating oils of various S.A.E. ratings
- dry ice
- tongs
- thermometre
- one test tube per sample
- alcohol
- one hole rubber stopper to fit test tube or corks cut with slit

Procedure:

A. Viscosity - Set up a water bath, a 400 mL beaker with an amount of water into which is placed a test tube containing approximately 10 mL of the oil sample. (No need to measure this volume so long as it is enough for the pipette.) Heat the bath to a temperature of 80°C and maintain this temperature.

from Consumer Science

Lab: 6a-4 "Lubricating Oils" (cont.)

If the pipette is prepared by the students, mark it so that some standard volume can be measured from one point to another but not to the bottom.

Using a pipette take exactly the volume of oil marked on the pipette and then allow it to flow back into the beaker. Accurately record the time in seconds that it takes for the sample of flow out.

Repeat the process until two trails check within one second.

It may be well to determine the viscosity at room temperature, also notice the change when heated.

Clean the beaker and pipette and repeat the above procedure with other oil samples. Record your results.

Oil		Rating	(80 C)	(80 C)	Room Temperature	

For oil to lubricate efficiently it must cling to the surface of the material. The viscosity tends to determine the "sticktuitiveness" of the oil but it must also flow freely. Trouble starting the car in cold weather is often caused by oils that have become too stiff. When this happens it tends to hinder or stop movement of the engine parts it is in contact with. The lowest temperature at which oil will flow is call its *pour point*. The government specifies that the pour point should not be below -40°F or above 5°C. However, under different circumstances there are different requirements; therefore the pour points are variable for different S.A.E. rating.

S.A.E. Rating	10	20	30	40	50	60	70
Pour Point For A Superior Oil	- 18°C	18°C	18°C	15°C	12°C	9°C	9°C

B. Pour Point - Make a freezing mixture by putting some dry ice into a 200 mL beaker and cover it with denatured alcohol (or by mixing ice with salt).

Caution: Do not handle dry ice with your hands, use tongs.

Using the same oil sample as above pour all but 3 cm of oil and insert a stopper or cork containing a thermometer so that the bulb is in the centre of the oil but not touching the bottom or sides of the tube. Put the apparatus into the freezing mixture and allow it to remain until the oil hardens. It will harden on the outside of the tube first, where it is exposed to the freezing mixture and gradually harden inward. As soon as all frozen remove the test tube and invert it. Notice when the oil just begins to flow around the thermometer this is the pour point; record the temperature.

Allow the oil sample to melt and repeat the process to obtain two readings within one degree.

Using the other samples of oil determine their pour points in the same way. Compare the pour points obtained with those specified by regulation. Do they meet the specifications?

C. pH before and after freezing and heating. Determine the pH of the oil samples before and after heating and before and after freezing. Record the data on a chart similar to that on page 82.

Questions:

1. How does temperature affect the viscosity of oils?
2. Explain the relationship of S.A.E. rating to viscosity.
3. Determine which oils should be used in summer and which should be used in winter. Explain why to use S.A.E. 10 or S.A.E. 40.
4. How does S.A.E. rating or viscosity relate to the quality of oil?
5. What does the pour point of oil indicate regarding its cold weather use?
6. Do your pour points compare with those specified by regulations? Why?
7. What pour point would you recommend for driving at temperatures of zero or below? Why?

Lab

Brand of Oil	S.A.E. Rating	Pour Points		Satisfactory or Unsatis.	pH Hot		pH Cold		Price	Rating
		1st Trail	2nd Trail		Before	After	Before	After		

Lab: "THE COMPONENTS OF COFFEE"

"Time for a coffee break!" The nation is conscious, everyone's drinking it! So much has been the surge of coffee drinking that a quicker cup of coffee became essential, therefore, instant coffee, just add hot water. Recently, however, some have become concerned about the quantity of coffee keeping them awake. Yet the comment is, "I don't want to stop drinking coffee though." As a result the coffee companies introduced the decaffeinated coffees, and psychologically the nation went back to sleep. Different brands of coffee contain different amounts of caffeine as well as other flavor additives.

Often fillers are added to fill out the pound and add to the color and consistency, such as cereals, roots, and even over roasted coffee. Chicory and other components may also be added to improve the flavor of the blend. Pure coffee will float, cereals, roots, oven roasted coffee and other fills will sink almost immediately. Coffee takes time to dissolve but if chicory is present color will develop immediately since chicory dissolves quite readily.

Equipment

- bunsen burner
- ring stand
- wire gauze
- 5 100 mL beakers
- 1 500 mL beaker
- 5 watch glasses
- separatory funnels
- chloroform
- ethyl alcohol
- teaspoon
- graduate
- coffee substitutes

Samples of:

- ground regular coffee
- ground decaffeinated coffee
- instant coffee-decaffeinated and caffeinated

from Consumer Science

Lab: "THE COMPONENTS OF COFFEE" (cont.)

Procedure

Place one teaspoonful of the coffee sample into 50 mL of cold water. Stir coffee sample slightly, observe if the sample floats, sinks, produces color, etc. Pure coffee will float but most of the fillers will sink quickly. Determine the approximate amount of filler. If the cold water becomes brown immediately, chicory is present.

Boil the coffee sample for five minutes, determine the approximate time to produce a deep color. Notice the effect upon any solids which had previously settled to the bottom. Allow to cool.

When cool, decant the brown solution into a separatory funnel and add 5 mL of chloroform. Leave the grounds in the beaker. Be sure that none of these solids get into the separatory funnel. Shake for about one minute. Be sure to hold the stopper tightly in place. Let the liquid settle into two layers and draw off into a clean test tube the dissolved caffeine. Set the sample aside to evaporate to dryness at room temperature. CAUTION: Keep chloroform away from flames, it is highly combustible.

After the chloroform has evaporated to dryness, add about 3-5 mL more of chloroform to redissolve the caffeine. Pour the chloroform solution into a small test tube. Allow the chloroform to evaporate and if a white sugary crystal is left, this is caffeine Determine the amount of caffeine by comparing the quantity of white residue from each coffee sample in each test tube.

Repeat the procedure with the other samples of regular coffee, decaffeinated coffee, instant coffee and coffee substitutes.

Compare the different samples to: filler content, chicory present or not, approximate time to produce a dark color, caffeine present or not, amount of caffeine, price per pound.

Lab: "THE COMPONENTS OF COFFEE" (cont.)

Procedure (cont.)

Sample	Filler Content	Chicory Present	Time to Produce Color	Amount of Caffeine	Price/lb.
1.					
2.					
3.					
4.					
5.					

Questions

1. Do many or any of the samples tested contain fillers? Which
2. How do decaffeinated coffees compare with the regular coffee in: caffeine content, in filler content, whether chicory is present and comparable price.
3. Does decaffeinated coffee really have most of the caffeine removed? Why?
4. Why is there so much of a concern to decaffeinated coffee?
5. From personal experience do you prefer regular or decaffeinated coffee? Why? Whether or not you prefer one or the other which do you recommend on the basis of your study?

Headache Preparations (Lab)

A headache is not a disease, yet it is more than just a nuisance. It is usually a symptom, a call for help, a signal that something is wrong. Occasional headaches are cause by fatigue, eyestrain, nervous strain, bad ventilation, or similar causes quite easily corrected. To overcome a headache of this kind, a doctor usually recommends more sleep, fresh air, or even one or two aspirins.

Headaches may be caused by other conditions that are more serious. Bad teeth, high blood pressure, and the early signs of kidney trouble may be the cause. "Many infectious diseases, such as scarlet fever, smallpox, infantile paralysis, and syphilis have headaches as one of their symptoms. The eye disease, glaucoma, which will quickly lead to blindness unless expertly treated is accompanied by splitting headaches. These are only a few of the diseases and ailments usually causing headaches."

A healthy body is always alkaline. Only the stomach juices, perspiration and urine are acid. There is such a condition as acidosis; but this is distinctly different from the overacid stomach or heartburn caused by eating too much, too fast, or when angry or tired.

There is also a condition known as alkalosis, which through not as common as acidosis, is even more serious. The use of alkalizers for such a condition is not only foolish from a chemical standpoint but is extrememly dangerous. It is therefore important to take these prescriptions in moderation. For this reason, many such remedies are buffered to control excess acidity and/or alkalinity.

Most bodily pains, including headaches, can be overcome by taking drugs. The drugs are merely temporary relief and may in some cases aggravate the body, sometimes causing permanent injury.

Most headache remedies and general pain killers are sold under commercial patented names which do not indicate the drugs contained. The Fed. Dept. of Health & Welfare requires that contents be listed on the label. Many people however do no read the label and many more do not understand it if they do.

Many pain killers contain acetanilid, acteophanetidin, or phenacetin drugs which even in the normal dosage of three grains can produce nervousness, skin disorders and even heart disturbances. Larger doses may cause delirium and collapse. Aminopyrine, previously used quite extensively is even more dangerous. It may produce skin eruptions, dizziness, chills and is even responsible for blood diseases that have been known to cause death.

Headache Preparations (Lab) (cont.)

Commonly used ingredients are also aspirin and caffeine. Caffeine is a narcotic which is a stimulant and may be harmful in large doses. Aspirin is fairly safe except for those directly susceptible to acetylsalicylic acid.

Equipment

- 3 small test tubes
- beaker (1-0 or 150 mL)
- Erlenmeyer (150 mL)
- pH paper
- phenolphthalein
- ring stand
- Bunsen burner
- clay triangle
- wire gauze
- ring support
- porcelain evaporating dish and/or crucible
- larger beaker (400 mL) water bath
- eyedropper
- graduate
- test tube holder
- balance
- headache preparations or pain killers
- .1 mol/m^3 Hydrochloric acid
- .1 mol/m^3 Sodium Hydroxide
- dilute Solium Hydroxide
- distilled water
- ferric chloride solution (10g/90 mL H_2O)
- dilute Hyrochloric acid
- Potassium Dichromate (1g/100 mL H_2O)
- Ammonium Hydroxide
- $KClO_3$
- $ZnCl_2$
- wood splints
- glacial Acetic acid
- .1 mol/m^3 Iodine solution
- 6 mol/m^3 nitric acid
- 1 mol/m^3 sulfuric acid

Procedure:

Buffering Action

Take one tablet or one gram of the headache preparation, make a solution by adding 50 mL of distilled water. Test each with pH paper to determine the degree of acidity or basicity. Divide each sample into two parts, add two drops phenolpthalein hydrochloric acid dropwise, counting the drops, to determine a color change in the indicator. Test again with pH paper. To the second half of the sample, add .1 mol/m^3 sodium hydroxide dropwise to again determine any color change. Record the number of drops.

Lab

Constituents of Headache Preparations:

A. Divide one headache preparation into three parts.

First portion - Test for Aspirin (Acetysalicylic acid).
Place this portion into 5 mL of distilled water and heat for several minutes but not to boiling. Cool and add a drop or two of ferric chloride solution: if a red-violet color is produced aspirin is present.

Second portion - Test for Acetophenetidin.
Boil this portion gently with 2 of dilute HCl for a few seconds; dilute with 10 mL of distilled water, cool, allow to settle and decant the liquid. To the decantant add a drop of potassium dichromate solution. If the mixture slowly develops a ruby red color acetophenetidin is present.

Third portion - Test for Caffeine.
Dissolve a very small amount of this sample, about .01 g in 1 mL of HCl in a porcelain evaporating dish or crucible add .1 g of $KClO_3$ and evaporate to dryness on a water bath (over a beaker of boiling water). Into a small test tube place a few drops of ammonium hydroxide. Invert the evaporating dish over the test tube, if caffeine is present the residue acquires a purple color, which disappears when a few drops of sodium hydroxide solution is added.

B. Divide another sample of the same headache preparation into four parts.

First and second portion - Test for Acetanilid.
Place about one-half of the total sample (two parts) into a small test tube and add about the same amount of zinc chloride. Heat this mixture with a piece of wooden splint in the mouth of the tube. White fumes may appear, continue heating until the mixture melts. It may turn yellow and then black. If the wood splint turns yellow, acetanilid is present.

Third portion - Test for Phenacetin.
Place one portion of the sample into a dry test tube. Add one or two drops of glacial acetic acid (concentrated), 1 mL of water, and 1 mL of .1 mol/m^3 iodine solution. Warm the mixture to about 40°C add one drop of hydrochloric acid, if phenacetin is present, reddish-brown leaflike crystals will form almost immediately. (If acetanilid is present, the crystals will not appear until the mixture has cooled.)

Fourth portion - Test for Aminopyrine.
Two tests are available for aminopyrine. Dissolve the remaining amount of portion four of the sample in 4 of water. Divide this solution into two parts.

Lab

1. Nitrous acid test.

   To the one-half solution prepared above, add a few drops of yellow nitric acid. If a purplish-blue color develops, aminopyrine is indicated.

2. Ferric chloride test.

   Confirm the presence of aminopyrine by adding one ml of 10% ferric chloride solution. A purple-to-violet color which changes to red when sulfuric acid is added confirms the presence of aminopyrine.

BUFFERING

Brand	pH	# Drops	Buffered?	Aspirin	Acetophenetidin	Caffeine

Acetanilid	Phenacetin	Aminopyrine

Questions:

1. At what pH does the color of phenopthalein change? How does the number of drops required to cause the change relate to the buffering action?

2. Determine which headache preparations are safer to use.

3. In your medicine cabinet investigate the labels of various preparation. Determine if any of these contained the referred to ingredients.

4. Which ingredients are no longer used to any great extent? Why?

Lab: "Natural and Synthetic Fibers"

Cotton and linen fibers are from plants; wool and silk fibers from animals. In which of these fibers would you expect to find starches and sugars? In which ones would you expect to find proteins?

Synthetic fibers are made from chemicals. Would you care to make a guess about the chemical elements in them?

This experiment may help you find some answers to these questions.

Equipment and Supplies per Lab Station

burner, laboratory; clamp, buret; ring stand
(6) test tubes, 18 mm x 150 mm
small dropper bottle of lead acetate solution (0.1 mol/m^3)
(6) strips each of red and blue litmus paper
samples of fabrics, cotton, linen, wool, silk, synthetics
copper wire, fine, 22 gauge, 4 cm, filter paper,

What to do

1. Place a small piece of each fabric to be tested in a separate test tube. Label each test tube. Test samples of cotton, linen, wool, silk, and synthetics.

2. Arrange each test tube in turn.

   a) Suspend a strip of damp red and a strip of damp blue litmus paper in the top of the test tube so that the two pieces of paper cannot touch. (What color change with the litmus shows the presence of nitrogen?
   ____)

   b) Cover the test tube with filter paper dampened with lead acetate solution. (What change in the lead acetate shows the presence of sulfur? __________)

from Action Chemistry

Lab: 'Natural and Synthetic Fibers" (cont.)

3. Heat each test tube in turn. Record in the Data Chart, any moisture form, any change in either litmus strip, any change in the lead acetate. (*NOTE:* Look for a change in either of the litmus papers.)

4. Examine the residue left in the test tube after the heating. Record its appearance in the Data Chart.

DATA CHART

Sample	Moisture formed	Litmus Reaction	Lead acetate	Residue-appearance
Cotton				
Linen				
Wool				
Silk				
?				
?				

Questions to answer

1. a) With which samples did moisture form?

   b) What chemical elements must have been present?

2. Which samples gave an acid reaction with litmus?

NOTE: This reaction is found with cotton and linen.

Lab: "Natural and Synthetic Fibers" (cont.)

3. Which samples gave both a basic reaction with litmus and a darkening of the lead acetate?

____

____

   a) These reactions show the presence of what two chemical elements? ______________________

   b) The presence of these two chemical elements shows the probable presence of what chemical compound? ______

   c) In which of the fabrics would you expect to find this chemical compound? Explain. __________

   ____

4. Is there any one chemical element which seems to be present in all of the fibers?

____

If so, what is it? __________ Explain. __________

____

5. The synthetic fibers are most like which of the natural fibers? Explain. ____________________

____

6. Look up the materials from which each of these two synthetic fibers is made:

   a) Nylon ______________________________

   ____

   b) Orlon ______________________________

   ____

   C) Any other synthetic fiber in which you are interested.

   ____

   ____

Lab: "Making Cold Cream"

Equipment and Supplies per Lab Station

beaker - 150 mL ; beaker - 250 mL ; evaporating dish
stirring rod, glass; test tube; thermometer
burner; clamp for test tube; clamp for thermometer
ring stand with ring and wire gauze; beaker tongs
2.5 g synthetic spermaceti wax; 2.4 g white beeswax
12 g white mineral oil, colorless; 4 mL borax solution

What to do

1. In your evaporating dish place the following quantities of waxes which have been cut into small pieces:
   2.5 g synthetic spermaceti wax
   2.4 g white beeswax

2. Place the evaporating dish on the top of a beaker of boiling water, as illustrated. Heat until the waxes are just melted at 80°C.

3. Pour 12 g of mineral oil *slowly* into the completely melted waxes. *Stir constantly.*

4. Turn out the fire. Remove the beaker and evaporating dish from the ring stand. Use beaker tongs or a very thick pad of paper towel to protect your hands.

5. Heat 4 mL of borax solution in a test tube to just 80°C.

6. Add the hot borax solution *slowly* to the melted wax and oil. *Stir the mixture constantly.* Constant stirring is necessary to obtain a good emulsion.

7. Remove the evaporating dish from the top of the hot beaker. Continue to stir the cold cream until it has cooled to room temperature. A drop of perfume may be added when the cold cream is at about 40°C. Stir in thoroughly. Transfer the product to a suitable container.

8. Describe the cold cream.

   a) What color is it? ______________________________

   b) What is its consistency, that is, thick?, soft?, smooth? ______________________________

from Action Chemistry

Lab: "Making Cold Cream" (cont.)

8. c) Does a tiny bit spread smoothly on the skin of your wrist? ____________________

NOTE: Be sure to wash it off completely.

Questions to answer

1. How do the emulsifying agents act to keep the waxes and oil mixed with the water?

____

____

2. Why is the perfume not added until the cream is cooled nearly to room temperature?

____

____

3. What is the source of spermaceti wax? (*Hint:* Look up *spermaceti* in the dictionary.)

____

____

____

Lab: "Making Lipstick"

Lipsticks are similar to cold cream in composition, but are firmer in consistency. Colors vary widely. They may be flavored.

Equipment and Supplies per Lab Station

beaker - 150 mL; beaker - 250 mL; evaporating dish
glass stirring rod; test tube, 13 mm x 100 mm; burner
ring stand with ring and wire gauze
masking tape; aluminum foil, 8 cm x 6 cm
3.0 g synthetic spermaceti wax; 2.6 g white beeswax
4.5 g white mineral oil; 1 or 2 drops of methylene blue

What to do

1. Melt together in your evaporating dish over hot water, as you did for cold cream:
   3.0 g synthetic spermaceti wax
   2.6 g white beeswax

2. Add *slowly*, with constant stirring, 4.5 g of white mineral oil to the melted waxes. Stir until well blended. Add on or two drops of any dye solution your teacher may provide.

3. Roll a strip of aluminum foil 8 cm x 6 cm around a very small test tube. Fasten the aluminum with masking tape. Crimp one end over to close it. See figure 99-B.

4. Push the warm lipstick mixture into the aluminum holder. Set the holder in a beaker of warm water, 60°C, so that the lipstick mixture will melt down into the holder. See Fig. 99-D.

5. Harden the lipstick by placing the holder in a beaker of ice water. Peel back the aluminum foil. Form a point on the lipstick. Try it on your wrist. Wash it off carefully.

Questions to answer

1. Why could the borax be omitted from the lipstick?

    ____

from Action Chemistry

Lab: "Making Lipstick" (cont.)

2. Look up in reference book kinds of dyes used to color lipstick.

   a) What are some of their sources? ____________________

   ____

   b) Why has the use of some of these dyes been prohibited by law? ____

   ____

Lab: "Determination of Vitamin C"

Introduction:

Vitamin C, one of a type of sunshine vitamin, is present in citrus and other fresh fruits. It may also be received by the body directly from the sun. Vitamin C, as a by-product, is often used as an additive to preserved foods, canned and frozen. It is often found in preserved foods, as a by-product of a type of preservative which produces vitamin C, in preventing spoiling (oxidation) of the food.

The precursor to vitamin C prevents spoilage by itself being oxidized instead of the food or juice, etc., to form vitamin C, thereby often times increasing the amount of the vitamin content of the food. It may be obtained for some freezing or home canning under a trade name as "Flavorsave" or the like.

Apparatus:

250 mL Erlenmeyer flask
pipette
200 mL beakers (3)
burette holder
burette
ring stand
knife
can opener
25 mL graduate

.01 mol/m^3 Iodine in KI sol. prepared one day in advance
starch indicator (boil 2 g, soluble starch in 500 mL of water)
Samples of fruit juices: canned grapefruit juice; frozen juices, orange, lemon, Tang, Vitamin tablets (vitamin C); soda pop; fresh fruit, oranges, lemons, grapefruit; any other.

Procedure:

A. Four samples of grapefruit juice are to be used:

1. Fresh grapefruit juice from the fruit.
2. Canned juice directly from a freshly opened can.
3. Canned juice allowed to stand open for a period of one week in the refrigerator (note the date opened).
4. Canned juice allowed to stand for a period of one week without refrigeration (note the date opened).

Approximately 1 mL of boiled starch indicator is added to a 25 mL sample of one of the above, which is placed in an Erlenmeyer flask. This is then titrated against a standard iodine solution until a *distinct* color change is noted. The number of milligrams of vitamin C per 100

from Consumer Science

Lab: "Determination of Vitamin C" (cont.)

of juice is calculated by the formula:

$$\frac{\text{mL of } I_2 \text{ used} \times .01\ \text{mol/m}^3 \times 88.08}{\text{mL of sample used}} \times 100 = \#\text{mg/100 mL of sample}$$

B. Repeat the above using the other samples available to determine the vitamin C content.

C. Repeat the above using the solid samples vitamin tablets, etc., prepared by dissolving the solid or tablet in 25 ml of water.

Questions:

1. Record your results for the grapefruit juice and draw conclusions as to the comparison of fresh versus canned and the relationship to exposure. Explain.
2. List the tested samples in order of decreasing content of vitamin C.
3. How does a multivitamin tablet compare to the other test samples? Why?

Lab: "Food Components (LAB)"

It is often desirable to know the components of various foods. There are many simple tests for detecting the presence of fats, proteins, carbohydrates, and starches.

Materials:

5 test tubes
test tube rack
small beaker
3 medicine droppers
Bunsen burner
filter paper
balance
olive oil
chopped up food (cookies, nuts, meats, orange peel, etc.)
egg yolk
millon reagent
tannic acid solution
glucose
Benedict's solution
citric acid crystals
iodide solution
HCl - dilute
watch glass
litmus paper
graduated cylinder 10 mL
evaporating disk
test tube holder
stirring rod
protein dispersion (2% egg albumin in water)
concentrated nitric acid
ammonium hydroxide
raw potato
mercuric chloride
sucrose
lactose
water soluble starch
iodine in potassium
carbon tetrachloride
NaOH

Procedure:

A. Fats.

1. Spot Test - Place one drop of olive oil and one drop of water side by side on a piece of filter paper. Observe the spots produced and determine the difference.

   Warm the filter paper by passing it back and forth over a flame, (be careful not to scorch the paper). Observe the results.

2. Extraction Tests - Break or chop some food which is suspected of containing fats into small pieces, such as cookies, meat, egg yolk, orange peel, nuts, or other foods. Just cover the food with carbon tetrachloride, and stir. (The vapors of CCl_4, are toxic: therefore, use it carefully and sparingly.) Decant the CCl_4 off into an evaporating dish and place it aside so the CCl_4 may evaporate. Observe what is left. Explain properties, composition, etc.

from Consumer Science

Lab: "Food Components (LAB)" (cont.)

B. Proteins.

1. Xanthoproteic Test - Add 1 mL of concentrated nitric acid to 3 mL of protein dispersion (2% egg albumin in water). Shake the mixture and warm gently. Indicate any change occurring. Add ammonium hydroxide slowly until the solution is basic (Test with litmus paper). The solution now should smell rather strongly of NH_4OH. Indicate the changes.

   Cut a small wedge of raw potato including the peel. Test this with the same xanthoproteic test as above with the HNO_3 and NH_4OH.

2. Millon's Test - Add a few drops of Millon's reagent to 3 mL of the protein dispersion. Notice the results.

3. Precipitation Reaction - Add 2 mL of mercuric chloride ($HgCl_2$) solution to 3 mL of the protein dispersion. Notice results.

   This is related to mercury poisoning in the body.

   Add 2 mL of tannic acid solution to 3 mL of the protein dispersion. What happens?

C. Carbohydrates (sugars).

1. Sweetness - Place a small quantity of glucose on your tongue and compare its sweetness with samples of sucrose and lactose. Rate the sweetness.

2. Benedict's Test - Boil 3 mL of Benedict's solution for one minute. If a precipitate forms either the test tube is dirty or the reagent is faulty. If no precipitate forms add a small quantity (a pinch) of glucose and warm the solution. Determine results.

   Repeat the above test with lactose and glucose.

   Place the pinch of sucrose in a test tube one-half full of water. To this solution add a few drops of hydrochloric acid, HCl, and boil for a few minutes. Test the solution with litmus, if acid add a drop or two of sodium hydroxide, NaOH, solution until basic to litmus. Perform the Benedict's solution test on this resulting solution. Notice any difference between this test on sucrose and the proceeding sucrose--Benedict's test.

Lab: "Food Components (LAB)" (cont.)

D. Starches.

1. Prepare a fresh starch dispersion by mixing 0.1 g of starch with 3 mL of water and adding the mixture to 10 mL of boiling water. What changes occur. Test a few drops of the starch dispersion with the Benedict's solution. What is the result?

2. To 3 mL of starch solution, add a small pinch of citric acid. Boil the mixture for two minutes. Test the resulting solution with Benedict's solution. What is the result?

   Add a few drops of iodine in potassium iodide solution to a few mL of the starch suspension. Notice the result.

   Repeat the I_2 in KI test with a piece of potato.

Questions:

1. Why is there a difference between the water and fat drops? What is the difference?
2. What property of fat is noticed after the filter paper is warmed?
3. Noticing the reaction of CCl_4 on fat, indicate the common use of CCl_4.
4. Explain the xanthoproteic test in so far as results are concerned.
5. Is protein found in the potato? Where? Explain how and why potatoes should be prepared.
6. Compare the xanthoproteic test to the Millon's reagent test (as far as results are concerned).
7. Explain mercury poisoning.
8. Relate the reaction of tannic acid on proteins to leather. Explain.
9. What is the difference between sucrose, glucose, lactose in so far as source is concerned?
10. Compare the Benedict's test on the three sugars. What assumption can you draw?
11. Why can't the starch be added directly to the boiling water when preparing the solution?
12. Compare the Benedict's test for the reaction with starch as compared to sugar.
13. Why is lemon juice added to pastry after the starch is cooked? (i.e., lemon juice to a lemon pie filling.)
14. Explain a good quick check for the presence of starch.

Lab: "Effects of Cigarettes on Living Animals"

In view of the present concern for the effect of smoking upon the human being it might be well to investigate the effects upon other creatures of a simple level. Professor Wang has experimented with the effect of cigarettes upon the Paramecium aurelia, a one-celled organism. He used four separate parts of nonfiltered cigarettes, the tobacco, the smoke, the ash of the entire cigarette, and the ash of the cigarette paper alone. His results were quite profound. In every case the paramecia were killed but in various ways, from placid to extremely violent deaths. This experience will deal with a similar exposure of paramecia to cigarettes, however, interesting and often times more dramatic results are obtained with planaria. Since they are larger and more easily seen, the results are more obvious.

Apparatus:

paramecia or planaria
three each of various brands
  of nonfilter and filter
  cigarettes
watch glasses
hand lenses
medicine droppers
rubber tubing

glass tubing
evaporating dishes
small test tubes
test tube rack
Bensen burner
ring and stand
wire gauze

Procedure:

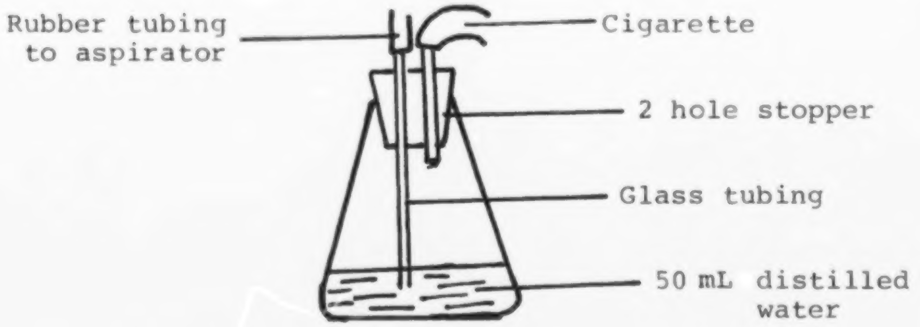
Each group will investigate the effects of one brand of cigarette upon the paramecia and planaria. It is imperative for comparative purposes to follow directions carefully so that all results may be evaluated by the total group. One watch glass will be kept as a control for comparison by all groups.

A. Tobacco.

Open an unburned cigarette, save the paper for part D and soak the tobacco for one-half hour in enough distilled water to just cover the tobacco; shake occasionally during this time. Allow the solid to settle and add five drops of this liquid to the colony of paramecium aurelia or to a planaria in a watch glass. Observe the animal through the hand lens. Describe what happens and how the animal reacts. Since the planaria are larger it may be necessary to add up to 30 drops in five drop

from Consumer Science

additions, observing after each addition, to get significant results. Closely examine the organisms, compare them with the control, and explain any changes that you might notice. Record the results. Draw a simple sketch of the dead animal, showing any changes. For comparison sketch the normal control specimen.



B. Smoke.

Add 50 mL of distilled water to clean 250 mL Erlenmeyer flask. Using the setup in the diagram, smoke the cigarette. Be sure the smoke from the cigarette bubbles through the distilled water. When the cigarette has burned down to the approximate butt size put out the butt but save the ashes for part C. Place five drop portions of the smoke solution in with another living sample in another watch glass, carefully observe the paramecia through the hand lens. Describe what happens and how the animals react. Closely examine the animals, compare them to the controls and explain any changes that you might notice. Record the results. Sketch the animals showing any changes.

C. Cigarette ash.

Collect the ash from part B and mix with an equal volume of distilled water. Mix occasionally for one-half hour. Allow the solid to settle and add five drop portions of this liquid to the animals in the watch glass. Observe them through the hand lens and again describe what happens and how they react. Closely examine the organisms, compare them to the control, and explain any changes that you might notice. Record the results. Again, sketch the animal to show any changes.

D. Cigarette paper ash.

Remove all traces of tobacco from the paper saved in part A. Carefully ignite the paper and burn it completely in an evaporating dish. Add an equal amount of distilled water and shake occasionally for one-half hour. Let the solids settle and add five drop portions of this liquid to another sample of organisms. Record and diagram as before.

E. Tobacco ash.

From another cigarette remove only the tobacco and burn this in an evaporating dish. It may be necessary to use the burner and blowtorch. Be sure that the tobacco is completely ashed. Mix with an equal amount of water and allow to stand, with occasional mixing, for approximately one-half hour. Add five drop portions of this liquid to another living sample and again record the results and diagram the animal.

F. Filter tip, unused.

For those cigarettes containing filters, test the effect of the filter upon the animals. Remove the filter, being sure to remove any tobacco clinging to it. Cut the filter in half to expose the inside and again add this to an equal amount of water. Allow to stand for one-half hour with occasional mixing and add five drop portions to another colony. Record the results and diagram the organism.

G. Filter tip, used.

Repeat part F but this time substituting a filter that has been used, from part C above.

Questions:

1. Do all of the animals die? How valid is the experience?
2. Does the above mean that all of the components are potential killers?
3. What specific differences are noticed in the dead animals?
4. From these differences can any assumptions be drawn?
5. Why is a one-celled animal like the paramecia aurelia used as a good test animal?

   Why is the planaria also a good sample animal to use?

BY ITS SMELL...

In the following exercise you will have an opportunity to make many of the smells you might find around your home in the kitchen cupboards!

Purpose:

You will prepare some common esters and try to identify their odour.

Materials:

Collect the following equipment for you and your partner:

1. 1 - 18 x 150 mm test tube
2. 1 - #1 one-hole stopper
3. 1 - 50 cm length 6 mm glass tubing
4. 1 - 250 mL beaker
5. 1 - test tube clamp
6. 1 - ring stand
7. 1 - ring
8. 1 - wire gauze
9. 1 - bunsen burner

You will also need one alcohol and one acid for each ester. These may be obtained from your teacher.

Procedure:

1. Set up the bunsen burner, ring stand, ring, wire gauze, and beaker to make a water bath as directed by your teacher.

2. Place 2 mL of ethanol and 2 mL of acetic acid in the

test tube. Caution: The acid could cause serious injury especially to your eyes. Please wear goggles during this lab.

3. Gently and carefully smell the mixture - but do not put you nose right over the test tube!
4. Add about 10 drops of concentrated sulphuric acid to the mixture. Again be very cautious - this acid is very corrosive.
5. Make sure the glass tubing through the rubber stopper is not plugged.
6. Carefully insert the stopper in the test tube. Mount the test tube in the water bath and hold it in place with the test tube clamp on the ring stand.
7. Heat the water bath until the mixture bubbles slowly. Boil for about 5 minutes, but do not allow it to boil vigorously!
8. Let the mixture cool for several minutes, then check the odour. Again, Do not put your nose directly over the test tube.
9. Try this procedure again with another acid and alcohol mixture from the ones listed below

Esters

1. Ethyl acetate: This is the ester you have just finished making. It should now smell just like nail polish remover.
2. Methyl salicylate: Mix and heat 1 g of salicylic acid with 1 mL of methyl alcohol. This should smell like oil of wintergreen.
3. Amyl acetate: Use 5 mL of glacial acetic acid and 3 mL of amyl alcohol. Do you smell bananas?
4. Ethyl butyrate: This time heat 2 mL of butyric acid and 2 mL of ethyl alcohol. Instant pineapples!

References:

Jenkins, F et al Alchem 20 Edmonton: JM LeBel Enterprises 1982

Joseph, A et al A Sourcebook for thePhysical Sciences New York: Harcourt, Brace and World 1961

Teacher's Notes:

Since the acids represent a potential hazard, make sure the students are instructed in the proper procedures for dealing with spills and make sure they wear their goggles

Instruct the students in the proper procedure for inserting glass tubing in rubber stoppers or prepare these ahead of time

Caution students about the proper way to smell chemicals Above all they should not put their noses directly over the test tube and inhale deeply!

PREPARATION OF ICE CREAM

CONCEPT: Making ice cream is an excellent way to demonstrate the concept of a chemical change.

MATERIALS:
tin can or metal container
test tube or toothbrush container
10 ml salt (2 teaspoons)
crushed ice
a Celsius thermometer
12 ml milk (1/8 cup)
a couple of pinches of salt
vanilla
swizzle stick or other thin stick

PROCEDURE:

1. Put the crushed ice into the metal container so that it is about 3/4 full.
2. Add the salt to the ice and stir until the temperature of the ice is between -8°C and -10°C. If the temperature is not low enough, add a bit more salt and keep stirring.
3. Put the milk, a couple of pinches of sugar and one drop of vanilla into the test tube.
4. Place the tube in the metal container and pack ice around it.
5. Stir the milk misture for 10 or 15 minutes, then your ice cream will be ready to eat.

DISCUSSION: Salt plays a role in lower the freezing point of water. The salt and ice will take away heat from the milk solution. It will eventually cool down enough to freeze.

An Alternate source of experiments might be Chemical Experiments from Daily Life, by Thomas McDuffie and Jacqueline Anderson. This book is available from J. Weston Walsh, through Western Educational Activities, P.O. Box 3806, Station "D", Edmonton, Alberta. T5H 2S7.

These activities were written for the average high school chemistry student. You may have to "dilute" a few of the labs if you plan on using them. A list of the Table of Contents is listed below.

1. The Strange World of Starch
2. Preparation of Wood's Metal
3. Further Investigation: Low Melting Alloys
4. There's Glass and There's Glass
5. Testing the Effectiveness of Suntan Lotions
6. Further Investigation: Instrumental Analysis of Suntan Lotions
7. Percent of Water in a Hydrate
8. Water of Hydration and the Weather*
9. Photography
   Commentary: Photochemistry - A Bad Image
10. Controlled Acid-Metal Reaction
11. Crystals: The Solid State*
12. Home Grown Crystal Garden
13. Antifreeze is also Anti-Boil
14. Fireproofing Clothes*
15. If the Oil Doesn't Flow, The Car Won't Go
16. Further Investigation: Effect of Temperature on Viscosity*
    Titration: A Useful Technique
17. Household Cleaners
18. Acetic Acid in Vinegar
19. Effectiveness of Antacid Tablets
20. Effect of UV Light on Detergent-Washed Clothes*
21. Measuring the Harshness of Soaps and Detergents
22. Comparing Soap and Detergent*
23. Synthesis of Soap and Detergent
24. Paints
    Commentary: Lead Poisoning - Can We Afford the Antidote?
25. Improving Upon Nature
26. Further Investigation: Citric Acid in Fruit Juice*
27. Testing the Strength of Aspirin
28. Synthesis of Aspirin
29. Decomposition of Aspirin
    Commentary: Generic vs Brand Name Drugs
30. Food, Glorious Food
31. Doesn't that Look Delicious?
32. Further Investigation: Identification of Food Dyes
33. Natural Dyes*
34. Health and the High Priced Spread
35. Milk and Its Sticky Step-Child
36. Further Investigation: Butterfat in Milk
    Commentary: Who Never Outgrows Their Need for Milk?

37. The Morning Cup of Coffee
38. Natural Indicators
39. Secrets of a Downstairs Maid
40. Further Investigation: Removing Rust
41. Corrosion of Metals
42. Electroplating
43. Temperature and the Formation of Plastic
44. Further Investigation: Reaction Rate and Amount Indicator

If you look at the contents from these experiments and key them to general textbook topics, you would arrive at a chart as shown below:

	EXPERIMENTS
Elements, Compounds and Mixtures	1, 2, 3, 4, 21, 22
Stoichiometry and Percentage Composition	7, 8, 13
Light Sensitive Chemical Reaction	5, 6, 9, 20
Replacement Reaction	10, 24
Properties of Solids and Liquids	11, 12, 13, 15, 16
Solutions	14
Acids and Bases, pH, Normality, Equilibrium, Indicators	17, 18, 19, 26, 38
Colloids and Suspension	23, 25, 28, 29
Organic Chemistry and Biochemistry	18, 27, 30, 31, 32, 33, 34, 35, 36, 37
Oxide Reduction	39, 40, 41, 42
Kinetics	43, 44

Choosing of this particular resource would be indicative of an above average class.

4. CONSTRUCTION SCIENCE

RATIONAL/OBJECTIVES

Man has been using materials for many thousands of years with varying degrees of intelligence. At first he used only those materials which were readily available in his immediate environment, but as civilization developed, he increasingly changed the forms of the materials and their properties to suit his needs. Man then began to move materials from their sources to the places where they were needed, so that he was able gradually to achieve mastery over materials. Thus, a complex technological society has evolved which now depends on an enormous number and variety of materials. The rate of development of new materials in the twentieth century has been usch that many articles we regard as essential could not have been made twenty or thirty years ago.

Our students will tend to take for granted the many natural and synthetic materials in everyday use. In this unit they are given an opportunity to consider their origins and properties and find out how these are related to their uses. The investigation of the relationship between the uses and properties of materials is, perhaps, the most important aspect of the unit. The investigations they carry out should show why certain materials are suitable for particular applications but at the same time it is important that the students should realize that all the properties of materials are not always ideally suited to their applications and that scientists have frequently been able to effect modifications. An example is the alloying of iron with other metals to produce a steel which does not rust.

Man has not only changed the properties of existing materials but has produced entirely new ones. and his ability to do this has never been more evident than at the present time. New materials such as plastics have transformed the domestic scene in the last few years and new applications for materials such as polyethylene and nylon are developing fast.

After completing this unit, the student will:

a) when asked to pick a location for a home, list a number of reasons for special care on siting an "arctic" dwelling.

b) when asked about house (building) design, comment on the forces/stresses involved.

c) be able to diagram a floor plan to suit a lifestyle for a given family.

d) recognize common properties of materials, suggest uses of materials:
- metals and alloys
- fuels
- synthetic materials
- natural products

Given properties, health considerations, functions and sources of common building materials the student will state:

a) appropriateness in the northern climate of common building materials and chemicals (finishing materials) in terms of feasability , practicality and cost.

The student will understand how the flow of heat energy through convection, conduction and/or radiation can be prevented through the use of insulative materials.

The student will be able to explain the purpose for a vapour barrier and how to construct a vapour barrier.

Knowing the importance of energy in our lives, and having an understanding of systems that may be used to maintaon comfortable temperatures in the home, the student will exhibit an awareness of the physical laws that govern energy loss and the human behavior that contributes to energy conservation.

EQUIPMENT REQUIRED

Balance beam
breakers
G clamps
Sodium metabisulphite solution
cement mix
tweezers
anhydrous calcium chloride
steel wool (1 spool)
glass wool
weights
thermometers
stoppers
strips of aluminum, copper, steel, iron, zinc, tin, magnesium
test tubes
test tube rack
crucibles (2)
clay triangle or asbestos wire mat
retort stand or tripod
bunsen burner or other heat source
emery paper
saran wrap
newspaper
iron nails
mixing bowl
wood stirring rod
tape
spatula
sheet plastic
bricks

RESOURCES

Each student should have a copy of:

Building Science (Science at Work Series)
Addison Wesley Publishing Ltd.
West End House
11 Hills Place
London. W1R 2LR

($17.50 Canadian for 5 student books)

Each teacher should have:

Building Science, Teacher's Guide

Addison Wesley

Additional Resources:

1. Household Energy, ISIS

   Ginn & Company, 1976

2. Rice, Eb

   Building In The North, (1975)

   Geophysical Institute
   University of Alaska
   Fairbanks, Alaska 99701

   Write to the Editor, The Northern Engineer, at above address.

The major resource for this unit is the text "Building Science" which should be followed as closely as possible. Certain modifications may have to be made depending on your location and type of materials used in local construction.

5. HUMAN PATHOLOGY AND HEALTH (Approximately 14 hours)

Rational/Objectives

5.1 In Science 11, the student studied the form, functions and inter-relation of the various human systems. Here, a review should take place so that students are prepared to study the sections that follow.

5.2 Rational

This unit offers to the student an understanding of infections and non-infectious diseases, micro-organisms which cause disease, human parasites, and how disease is spread. In addition to organic causes, genetic, self-inflicted and safety/industrial related courses should be explored for common disorders.

After completion of this unit, the student will:

a) differentiate between communicable and non-communicable diseases.

b) describe how viruses cause disease.

c) describe how diseases caused by bacteria

d) identify diseases caused by protozoa; by fungi.

e) discuss different types of parasetic worms.

f) identify ways communicable diseases are spread.

5.3 For Common Disorders (Public Health Concerns)

When faced with a description of a medical case, the student will be able to:

a) identify the disorder.

b) name (and explain) the agent of disease causing the disorder.

c) analyze the disorder/disease.

d) suggest/prescribe a cure.

e) be able to identify unhealthy practices and situations.

REFERENCES

a) Consult Public Health Organizations

Department of Health
Environmental Health
Alcohol and Drug Education

b) The Body in Question (T.V. Series)

c) When Temperatures Drop

Canadian Red Cross Society

d) Foods and Micro-organisms
Heart Attack
Cells and Cancer
} I.S.I.S., Ginn & Company

A brief outline of the three I.S.I.S. books follows:

a) Food and Micro-organisms deals with bacteria, molds and yeasts. These tiny organisms have many roles, some useful, some harmful. Some help plants grow and make up better while others cause decay of plants and others make us sick. In this mini-unit, the student discovers how micro-organisms affect us.

b) Heart Attack explains what causes heart attacks and strokes, what makes you a risk, and also describes the detection and first aid associated with heart attacks.

A detailed explanation of your circulatory system is described through a series of activities.

c) Cells and Cancer discusses the signals/warning signs of cancer, diagnosis and treatment of this disease. It also deals with the risks people take every day of their lives through their life styles.

It is suggested that the teacher ascertain the areas which adequate previous treatment of subject matter has occurred and zero in on other less-covered areas. A student project in one of the disorders followed up by a class presentation may be one way of covering some of the material in this unit.

ELECTIVE: PHOTOGRAPHY

CONTENTS:

1. How Film Takes a Picture
2. The Pinhole Camera
3. A Simple Camera
4. Using a Commercial Camera
5. Developing the Film
6. Making Positive Prints
7. Enlarging
8. Uses of Photography

REMARKS:

It is hoped that the various aspects of photography and its uses be employed throughout the course to highlite learning.

CATALOG NUMBER	TEXT NAME	COST
14005-5	Photography	17.77 per unit. Each unit comprises 5 student books and 1 teacher's guide.

Available from:

Addison Wesley
P.O. Box 580
26 Prince Andrew Place
Don Mills, Ontario
M36 2T8

ELECTIVE: USING THE SKIES

CONTENTS:

1. Planning
2. Astrology and the Zodiac
3. Stars in Motion
4. Finding Constellations
5. Stopping the Sun and Stars
6. It All Depends on Your Point of View
7. Distances in the Solar System
8. Time Under the Sun
9. A sense of Direction

REMARKS:

This unit deals with constellations and planets; a subject which usually generates a great deal of interest in students.

CATALOG NUMBER	TEXT NAME	COST
663-40282-4	Student booklet	5.30
663-40286-7	Teacher's edition	8.60
663-37953-9	Duplication masters (test)	16.95
663-33657-0	White sky template(1 set)	7.60
663-33658-9	Black sky template(1 set)	7.60
663-33659-7	Moon guide card (1)	2.75

Available from:

Ginn & Company
3771 Victoria Park Ave.
Scarborough, Ontario
M1W 2P9

ELECTIVE: HUMAN REPRODUCTION

CONTENTS:

1. Planning
2. The Beginning of Life
3. Transferring Sperm and Egg
4. A Human Being Forms
5. Life Before Birth
6. The Menstrual Cycle
7. Cycles and Feedback

REMARKS:

The advanced activities in this book deal with topics such as family planning, male and female hormones and venereal diseases.

CATALOG NUMBER	TEXT NAME	COST
663-40224-7	Student booklet	5.30
663-40229-8	Teacher's edition	8.60
663-40234-4	Duplication masters (test)	16.95

Available from:

Ginn & Company
3771 Victoria Park Ave.
Scarborough, Ontario
M1W 2P9

ELECTIVE: GETTING ENOUGH OXYGEN

CONTENTS:

1. Planning
2. Your Breathing System
3. Moving the Air
4. Diagnosis
5. At Cell Level
6. Handling Breathing Emergencies
7. Do You Control Your Breathing
8. Getting to Your Cells and Back

REMARKS:

This unit deals with how your breathing system works, why you need it and how you can affect it. The student will also learn why oxygen is so important and how you can help someone who isn't getting enough of it.

CATALOG NUMBER	TEXT NAME	COST
663-33756-9	Student booklet	5.30
663-33546-9	Teacher's edition	8.55
663-37947-4	Duplication masters (test)	16.95
663-33548-5	Diagnosis game (2)	25.25
663-33549-3	Cassette tapes (2)	25.25

Available from:

Ginn & Company
3771 Victoria Park Ave.
Scarborough, Ontario
M1W 2P9

ELECTIVE: BUYING AND SELLING

CONTENTS:

1. Planning
2. Is Seeing Believing
3. Listen to This
4. Buyers choice
5. It's All in How You Look At It
6. Label Language
7. Buy the Gram or Buy the Litre
8. Do Not Fold, Staple or Mutilate
9. Armchair Scientist
10. Testing, testing
11. Getting the Message
12. Extension Activities - Jingles and Ads

REMARKS:

CATALOG NUMBER	TEXT NAME	COST
663-33768-2	Student Booklet	5.30
663-33632-5	Teacher's Edition	8.55
663-33633-3	Duplicating Masters (Tests)	8.55
663-33634-1	Cassette tapes (2)	25.25

Available from:

Ginn & Company
3771 Victoria Park Ave.
Scarborough, Ontario
M1W 2P9

ELECTIVE: LET'S EAT

CONTENTS:

1. Core Planning
2. Food - More Than Just For Eating
3. Food Record
4. Feeling Full Is Not Enough
5. Food Energy - How Much Do You Get
6. A Poor Insurance Risk
7. Calories and the Company They Keep
8. A, B, C, and Minerals
9. Sweet Teeth Hazards
10. Haves and Have Nots
11. Technology and Food
12. How to Stop Overeating

REMARKS:

In this unit, the student will learn about food requirements for good health. You will compare what you eat with what food experts say you need. You will also look at what is happening to the production of food in the world today and the problems some people face.

CATALOG NUMBER	TEXT NAME	COST
663-34839-0	Student booklet	5.30
663-34841-2	Teacher's edition	8.60
663-37963-6	Duplication masters (test)	16.95
663-34843-9	Diet data booklets	25.00

Available from:

Ginn & Company
3771 Victoria Park Ave.
Scarborough, Ontario
M1W 2P9

EVALUATION OF STUDENT ACHIEVEMENT

It is expected that teachers will ensure that the student evaluation strategies utilized in this program will be such as to allow the student every possible opportunity to demonstrate his or her mastery of the objectives.

Due to the diverse nature of the content it is strongly recommended that a large proportion of the final mark for a unit be determined at the end of the unit rather than at the end of the year/semester. Year/Semester-end evaluation should concentrate on the general objectives rather than specific unit content.

At the beginning of the term, the students should be provided with a course outline and an evaluation scheme. These guidelines should form part of the teacher's long range and unit lesson plans.

Students on the average tend to experience greater success when they are given immediate feedback on assignments, especially those of a short term nature.

Evaluation may include some or all of the following:

daily assignments
short term assignments
attendance
attitude
reports
exams, quizzes
laboratory work
participation
field study
projects

Three approaches to evaluation that you may want to consider are outlined below.

I. "+, 0, -" APPROACH

This system relies upon a teacher's interpretation of the "+, 0, -" symbols. For example, a "+" may designate well done, complete or near complete assignments, attending and working, or a good attitude in class. A "O" may designate work done but not completed, attending but not working well, or a weak attitude but still positive. A "-" would designate work poorly done, assignments not handed in, a popor attitude towards the course, or not participating.

Teachers could record a "+, 0, or -" every day or periodically and report weekly tabulations to students. When report card time arrives, one could add up the pluses and equate this total to a mark out of 10 - 15 - 20%, whichever is desirable.

The suggestions here are not limited and the scale could be expanded to a 1-5 scale if more categories were desired. A sample five point list of criteria is found in Table 1 entitled "Sample Impressionistic Scoring Criteria".

This strategy could be utilized in evaluating short homework assignments, attendance, attitude, participation in lab or desk work, or in discussion activities

II. IMPRESSIONISTIC SCORING

This approach deviates considerably from traditional quantitative scoring to qualitative scoring. A teacher should develop a scoring scale with qualifying statements describing the expected achievement for various points along the scale.

Impressionistic scoring is readily adaptable for scoring written assignments, essays, reports or labroatory write-ups. One may desire to develop different scales for major reports as opposed to laboratory write-ups.

One example of impressionistic scoring criteria is provided in Table 1. Teachers may want to develop their own qualifying statements. At report card time one may want to add up all of these marks and then equate them to a percent.

III. QUANTITATIVE SCORING

This is the traditional scoring approach utilized by teachers. It is readily used when evaluating student achievement on examinations, assignments and quizzes. Many marks from frequent evaluations should be collected and reported in terms of raw scores and then converted to a percentage score.

IV. EVALUATIVE RECORDS

Records of student achievement on assignments, participation, attendance, etc. should be maintained. This information should allow for: 1) discussing with students their progress in the course; 2) providing information to parents or administration through reports, cards; and 3) planning for instruction of the program.

A PROGRAM EVALUATION QUESTIONNAIRE

FOR USE WITH STUDENTS

Developed by

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Adapted by

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PURPOSE

Student responses to this questionnaire are intended solely for the use of the classroom teacher. Students are asked not to indicate their name on the evaluation instrument. It is intended that the teacher, through analysis of the responses given, will gain insight into the manner in which his/her students perceive their learning environment. Areas covered by the evaluation include:

- attitudes of students to the school environment and program area
- program interest and expectations
- management of learning and classroom environment
- methodologies employed
- evaluation of students

As a result of insights gained, the teacher may wish to modify his/her program and/or teaching style to better suit the needs and perceptions of students. A question which would guide teacher analysis of results should be

> "IS THE INFORMATION REVEALED POTENTIALLY USEFUL FOR IMPROVING MY PROGRAM OR REFINING MY TEACHING PRACTICES ?"

Teachers may wish to include additional questions and are encouraged to do so, however the criteria for the design and use of each question should be kept in mind. Questions requiring written responses pose three potential difficulties:

- a decrease in the objectivity of the survey
- decreased facility in tabulating results
- possible loss of student anonymity

INTERPRETING THE DATA

Use a blank questionnaire to tabulate the number of results in each of the five categories.

Section A deals with the student's personal assessment of his or her achievement in a class. Sections B through D may be interpreted in light of the student's reply to Section A.

Section B reveals factors which the student feels affect achievement in a program area in a positive or negative way.

Sections C and D are designed to reveal the student's reaction to various aspects of the program, methodology, evaluation procedures and classroom management. The questions are grouped according to the following categories:

* Attitudes -- 1-6
* Program -- 7,8; 16-20; 38-41
* Management -- 10-12; 27-32
* Methodology -- 9; 13-15; 33-35
* Evaluation -- 21-26; 36,37

FOLLOW-UP

The questionnaire may not disclose all the information that a teacher may require, but it can serve as a valuable initial step in the revision of program practices.

QUESTIONNAIRE FOR SCIENCE STUDENTS

COURSE: ________________

SECTION A

How would you rate your success in this program. Circle one response.

Highly Successful-----------5

Very Successful-------------4

Reasonably Successful------3

Somewhat Successful---------2

Unsuccessful----------------1

SECTION B

Place the appropriate number (from 5 to 1) in the blank space provided at the end of each item to indicate your personal view:

a) 5 indicates a "very positive effect"

b) 4 indicates a "somewhat positive effect"

c) 3 indicates "no effect one way or the other"

d) 2 indicates a "somewhat negative effect"

e) 1 indicates a "strongly negative effect"

1) What effect has your attitude to school in general had on your achievement _______

2) What effect has your attitude to this program in particular had on your achievement _______

3) What effect has the influence of your peers or classmates had on your achievement _______

4) What effect has the teacher's attitude to you had on your achievement _______

5) What effect has the teacher's enthusiasm for Science and its value had on your achievement ______

6) What effect has the importance of Science to your career plans had on your achievement ______

7) What effect has your interest in the materials used in this program had on your achievement ______

8) What effect has your interest in the topics on which you have written, and the assignments you have done had on your achievement ______

9) What effect has the effectiveness of the teaching methods used in class had on your achievement ______

10) What effect have the routine, rules and regulations established for classroom behaviours had on your achievement ______

11) What effect have the teacher's comments concerning your work or your answers had on your achievement ______

12) What effect has the learning atmosphere which exists in the classroom had on your achievement ______

13) What effect has the amount of time the teacher devotes to you personally had on your achievement ______

14) What effect has the ability of the teaching methods or activities to motivate you had or your achievement ______

15) What effect has the emphasis which your other subject teachers place on the importance of developing Science skills had on your achievement ______

SECTION C

Place the appropriate number (from 5 to 1) in the blank space provided at the end of each item to indicate your personal response.

a) 5 indicates "all of the time"

b) 4 indicates "most of the time"

c) 3 indicates "some of the time"

d) 2 indicates "occasionally"

e) 1 indicates " not at all"

16) Is the material studied enjoyable ------

17) Is the level of difficulty at which the material is discussed suitable to this grade level ------

18) Are the topics of interest ------

19) Is the quality of work expected of you reasonable ------

20) Is the workload in this program reasonable ------

21) Do you feel that the teacher's marking of your assignments is fair ------

22) Do the marks given by the teacher to your assignments accurately reflect your ability ------

23) Are the teacher's comments on your written assignments helpful in improving the quality of your writing ------

24) Are the teacher's comments on your assignments helpful in improving the quality of your work ------

25) Is the marking of your assignments based on standards or criteria clearly established at the time the assignment was given ------

26) Does the mark you receive on an assignment reflect a fair division of emphasis among
  - a) the quality of thought
  - b) the quality of expression
  - c) accuracy of the content

______

27) Does the teacher dominate the classroom discussion too much of the time ______

28) Does the teacher respect students' ideas and opinions, even if there may be disagreement over the interpretation of a question ______

29) During classroom discussions, are students encouraged to listen to and respect the ideas and opinions of other students ______

30) Do certain students dominate the classroom discussion so much of the time that others are unable to contribute ______

31) Does the teacher maintain sufficient control of the class so that learning can take place ______

32) Is the teacher's classroom discipline fair ______

33) Does each lesson have a clearly stated topic or learning purpose ______

34) Is the homework sufficiently discussed for you to assess the quality of your work against the quality expected in the assignment ______

SECTION D

Place the appropriate number (from 5 to 1) in the blank space provided at the end of each item to indicate your personal view.

a) 5 indicates "very often"

b) 4 indicates "often"

c) 3 indicates "some of the time"

d) 2 indicates "occasionally but not enough"

e) 1 indicates "not at all"

35) Are teaching methods and classroom activities sufficiently varied ________

36) Are assignments evaluated and commented on with sufficient frequency by the teacher and/or your classmates to contribute to your progress ________

37) Are tests and assignments of various types given, marked and commented on often enough to allow you to know, throughout the program, how well you are achieving ________

38) Is the development of writing and and communications skills sufficiently emphasized ________

39) Is the appreciation of, and our dependency on scientific knowledge sufficiently emphasized ________

40) Are the practical aspects of Science necessary for the working world and day-to-day life sufficiently emphasized ________

41) Are the building of research skills and the independent discovering of information sufficiently emphasized ________